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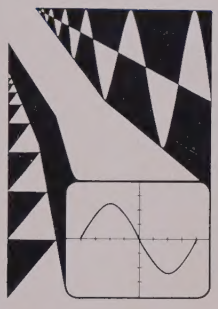

Portable 50MHz storage multiplier oscilloscope

PM3243

9499 440 17102

770425/1/01-03

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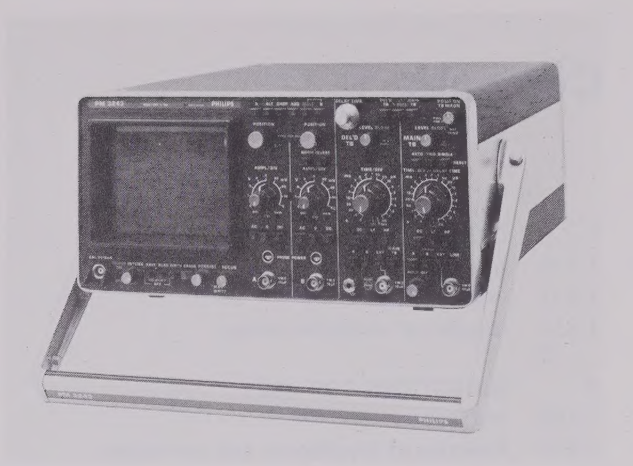

Instruction manual
Gerätehandbuch
Notice d'emploi et d'entretien

Portable 50 MHz storage multiplier oscilloscope

PM3243

This insert must be used
with the manual of the
basic PM 3240 oscilloscope

Order number of
this insert 9499 440 17102

770425/1/01-03

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Instruction manual

1.General information

1.1. INTRODUCTION

The PM 3243 Portable 50 MHz Storage Multiplier Oscilloscope enables the measurement, storage and multiplying of signals at a high sensitivity (5 mV/DIV).

A wide choice of display modes is available, such as single channel operation, two channels alternately or chopped, two channels added, with normal and inverted position for one input signal, two channels multiplied, and a main and delayed time-base.

The PM 3243 oscilloscope features a tapless power supply with low dissipation.
The power supply operates satisfactorily from any a.c. mains voltage between 90 V and 264 V, or any d.c. voltage between 100 V and 200 V, thus obviating the need for adjusting the instrument to the local mains voltage.

All these features combine to make the PM 3243 oscilloscope suitable for a wide variety of applications.

Features

Summarising, the PM 3243 oscilloscope is characterised by the following features:
- 5 mV sensitivity at 50 MHz.
- Built-in 40 MHz multiplier.
- Simultaneous display of the product and one of the factors.
- Variable persistance and storage.
- Advanced design.
- Highly efficient power supply unit, operating from a wide range of a.c. or d.c. voltage supplies without voltage switching.

Note: The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.

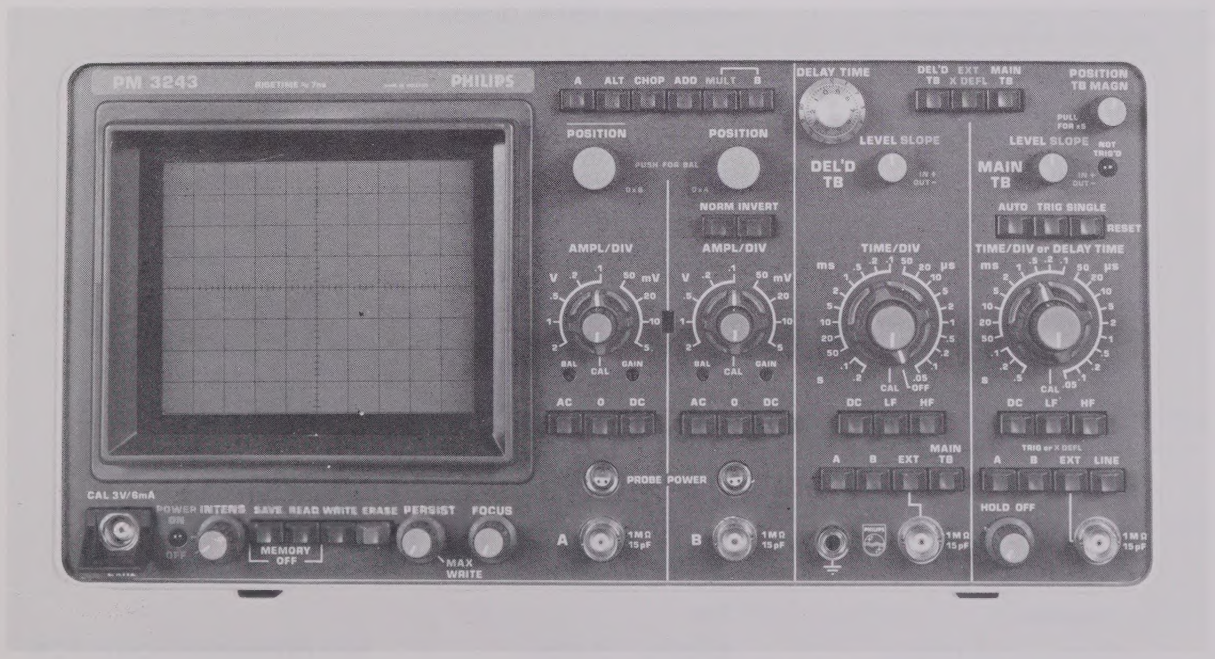


Fig. 1.1. PM 3243

1.2. CHARACTERISTICS

This instrument has been designed and tested in accordance with IEC Publication 348 for Class 1 instruments and has been supplied in a safe condition. The present Instruction Manual contains information and warnings, which shall be followed by the purchaser to ensure safe operation and to retain the instrument in a safe condition.

This specification is valid after the instrument has warmed up for 30 minutes.

Properties expressed in numerical values with tolerances stated, are guaranteed by the manufacturer. Numerical values without tolerances are typical and represent the characteristics of an average instrument.

Designation	*Specification*	*Additional information*
C.R.T.		
Type	89L14GH/55	Rectangular, post-accelerator half-tone storage tube
Useful screen area	8 x 10 div.	1 division = 0,9 cm
Screen type	P31 phosphor	
Total acceleration voltage	8,5 kV	
Graticule	Internal	
Persistence		
Normal	Natural persistence of P31 phosphor	(10 μs ... 1 ms)
Variable	Continuously variable from 0,3 sec. to 1,5 min.	
Storage time		
In 'write' mode (max. persist.)	1,5 min.	
In 'read' mode	3 min.	
In 'save' mode	15 min.	
Writing speed		
Normal	0,2 div./μs	
Max. write	2 div./μs	
Erase	Pushbutton operated, erasure takes 800 ms (approx.)	
Vertical or Y Axis		
Number of channels	2	
Display modes	Channel A only Channel B only A and B chopped A and B alternated A and B added A x B multiplied A x B and B, chopped The polarity of channel B can be inverted	
Chopping frequency	1 MHz	
Display time per channel	Approx. 500 ns	
Bandwidth	d.c. .... 50 MHz	d.c. coupled Upper bandwidth limit −3 dB
	10 Hz ... 50 MHz	a.c. coupled −3 dB bandwidth limit
Risetime	7 ns	
Deflection coefficients	5 mV/div ... 2 V/div	Nine calibrated positions in 1-2-5-sequence. Uncalibrated, continuous control between the steps 1:2,5

Designation	*Specification*	*Additional information*
Accuracy	± 3 %	
Over/undershoot	2 % max.	
Max. permissible input voltage	± 400 V	d.c. + a.c. peak
Input impedance	1 Mohm//15 pF	
Input coupling	AC-0-DC	
Input RC time	22 ms	a.c. coupling
Attenuator balance	0,2 DIV max.	Trace movement when switching between any of the attenuator settings, or when operating continuous control.
Instability of spot position	0,05 DIV/hour max. 0,01 DIV/°C max.	 +10 °C . . . 40 °C
Dynamic range	24 DIV 6 DIV max.	15 MHz sine wave 50 MHz sine wave
Position range	16 DIV	
Crosstalk between channels A and B	40 dB	Chopped or Alternate (d.c. . . . 50 MHz)
Max. total input signal amplitude at A minus B	24x attenuator setting	
Multiplier		
Bandwidth	d.c. - 40 MHz	– 3 dB Multiplier bandwidth to be measured with sinewave signal on one channel an a DC signal to the other
Display modes	AxB AxB and B	+ or – B + or – B, chopped
Rise time	9 ns	
Scale factor	1 ± 2 %	Scale factor with respect to display heights of either factor or products
– Dynamic range		
Signal A or B	8 DIV	(± 4 DIV from centre)
Signal A x B	8 DIV	(± 4 DIV from centre)
Non linearity	± 4 % max.	Of full screen deflection
Feed through	0,2 DIV max.	–30 dB
Product off-set	0,2 DIV max.	
Product off-set drift	0,03 DIV/°C max.	
Propagation delay	8 ns max.	
– Output	BNC socket at rear	d.c. coupled
Scale coefficient	100 mV/DIV ±4 % 50 mV/DIV ±5%	10 kohm load, within dynamic range 50 ohm load, within dynamic range
Pulse aberations	5 %	
Output off-set	10 mV max.	10 kohm load, externally adjustable
Output drift	3 mV/°C	10 k ohm load

Designation	*Specification*	*Additional information*

Horizontal or X Axis

Horizontal deflection can be obtained either from the Main time base or from the Delayed time base, a combination of the two, or from the signal source selected for X-deflection. In the last-mentioned case, X-Y diagrams can be displayed using ch. A or B, the EXT. connector or the line (mains) as a signal source for horizontal deflection.

Display modes	Main time base Main time base intensified by delayed time base Delayed time base X-Y operation	 by Y_A, Y_B, External or Line (mains)

Horizontal amplifier

Bandwidth	d.c. ... 1 MHz over 6 div. –3 dB upper limit	
Deflection coefficient	450 mV/div. using EXT connector Vertical attenuator coefficients apply when Y_A or Y_B is used for X deflection	
Input impedance	1 MOhm//15 pF	
Measuring accuracy	± 10 % using Y_A or Y_B input	
Phase error	3^o at 100 kHz	

Main time base

Modes	Auto - triggered - single shot	
Time coefficients	0,5 s/div ... 50 ns/div in 1-2-5 sequence. Uncalibrated continuous control between steps 1:2,5 x5 magnifier extends max. sweep rate to 10 ns/div.	
Variable hold-off	Sweep hold-off time can be increased by at least a factor of 5.	
Accuracy	± 3 % Except: 0,5 sec and 0,2 sec ± 5 % 100 and 50 nsec ± 5 % Sweep accuracy over any two divisions of 10 div sweep is ± 5 % Exclude the first and last div at the 10 ns/div and 20 ns/div magnified sweep rates.	

Delayed time base

The delayed time base either starts immediately after delay time or can be triggered after delay time by the selected time base trigger source.

Time coefficients	0,2 s/div ... 50 ns/div in 1-2-5 sequence. Uncalibrated control between steps 1:2.5. x 5 magnifier extends max. sweep rate to 10 ns/div.	
Accuracy	± 3 % Except: 0,2 sec ± 5 % 100 and 50 nsec ± 5 % Sweep accuracy over any two divisions of 10 div sweep is ± 5 % Exclude the first and last div. at the 10 ns/div and 20 ns/div magnified sweep rates.	
Sweep delay	In steps, variable with main time base. Continuously variable by 10-turn potentiometer between 0,2x and 10x the time coefficient of the main time base.	
Delay time jitter	1:20.000	
Incremental delay time error	0,5 %	
Delayed gate output	Rear panel connector providing logic "1" TTL output pulse during main time base intensified and delayed time base running times. For Multiplier applications.	

Designation	*Specification*	*Additional information*
Main time base triggering		
Trigger source	Internal ch. A or B External Line (mains)	
Slope	+ or −	
Trigger coupling (see Fig. 1.2.)	DC (DC . . . 50 MHz) LF (DC . . . 50 kHz internal - 10 Hz . . . 30 kHz external) HF (50 kHz . . . 50 MHz) Auto freerun (reaction time $\leqslant$ 100 nsec)	
Sensitivity	Internal $<$ 0.5 DIV (1/3 DIV typ) External $<$ 150 mV (100 mV typ)	
Level range	Internal 24 div. typical External −5 to +5 V typical	
Ext. input impedance	1 MOhm//15 pF	Identical to Y-input
Delayed time base triggering		
Trigger source	Internal, ch. A or B External Other trigger specifications of the delayed time base are identical to those of the main time base.	
Amplitude calibrator		
Voltage	+3 V	Square wave, base-line zero volts
Current	6 mA	Square wave, through current loop
Accuracy	± 1 %	For both voltage and current
Frequency	2 kHz ± 2 %	
Protection	The output is short-circuit-proof	
Power		
Line voltages	Accepts any voltage between 100 V and 240 V ± 10 % at any frequency between 46 and 440 Hz in one range, without switching.	
DC power service	Accepts any d.c. voltage between 100 V and 200 V	
Power consumption	39 W	
Probe power	Two sockets providing +24 V and −24 V for active probes. Current drain max. 2x50 mA for each output.	
Environmental capabilities		
Note:	*The environmental data are valid only if the instrument is checked in accordance with the authorised checking procedure. Details on those procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.*	
Ambient temperature	+5 deg. C ... +40 deg. C rated range of use −10 deg. C ... +55 deg. C operating −40 deg. C ... +70 deg. C storage and transit	
Altitude	To 5.000 m operating To 15.000 m not operating	
Humidity	Meets IEC 68 Db requirements	
Bump tests	1000 bumps of 10 g, ½ sine, for 6 ms duration in each of three directions.	
Vibration	30 min. in each of three directions, 10 Hz ... 150 Hz, 0,7 mm_{p-p} and 5 g max. acceleration	

Electromagnetic intereference	Meets VDE, Störgrad K	
Recovery time	Operates within 15 min. of being subjected to −10 deg. C, soak, then taken into room conditions of 60 % relative humidity at +20 deg.	
Dimensions and weight	Height	154 mm
	Width	316 mm
	Depth	460 mm
	Weight	10,6 kg

Instrument options

The following options are available as service modifications.
Contact your local Philips field service engineer for details.
- Main time base sweep output
- Main time base gate output
- Delayed time base sweep output

Accessories

Supplied with the instrument

Two passive 1:10 probes

Contrast filter
Front cover
Collapsible viewing hood PM 9366
BNC banana adaptor PM 9051
Cal. terminal to BNC adaptor
Operating and service manual.

Some of above mentioned accessories are located inside the front cover.

Optional

PM 9335	Passive probe set 1:1 (1,5 m)
PM 9335L	Passive probe set 1:1 (2,5 m)
PM 9350	50 MHz passive probe set 10:1 (1,5 m)
PM 9350L	50 MHz passive probe set 10:1 (2,5 m)
PM 9358	150 MHz HV probe set 100:1
PM 9347	Active TV triggering probe
PM 9352	Micro miniature probe
PM 9353	Active FET probe 150 MHz
PM 9355	Current probe
PM 8910	Polaroid anti-glare filter
PM 9380	Oscilloscope camera
PM 8971	Camera adaptor
M3 ... M5	Steinheil Oscilloscope camera range
PM 8960	19" Rack mount adaptor
PM 8980	Long viewing hood
PM 8901	Rechargeable battery pack 140 V d.c.
PM 8991	Trolley
PM 8992	Accessory pouch

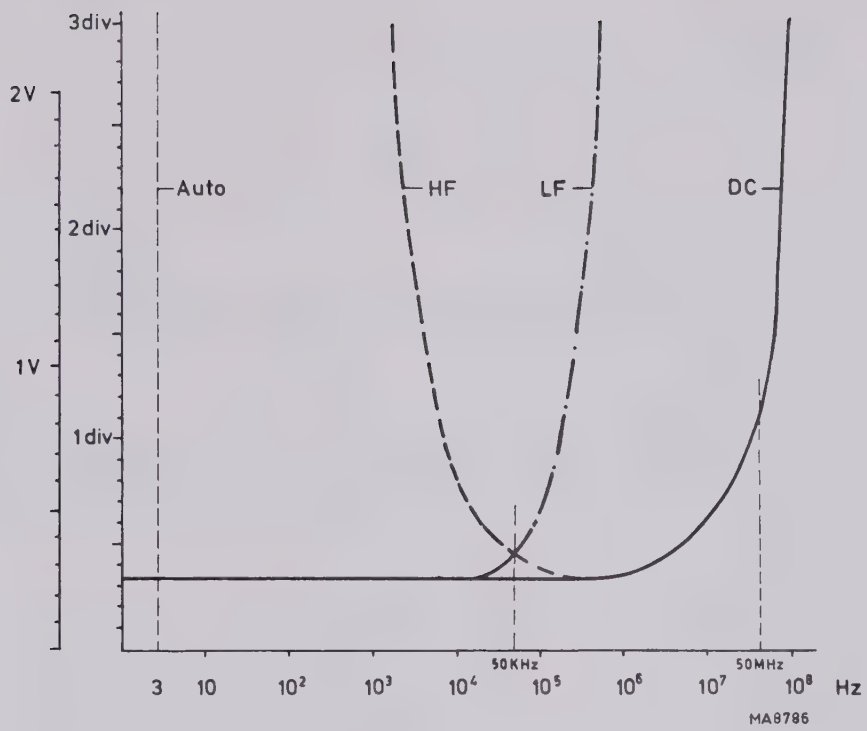


Fig. 1.2. Typical trigger sensitivity as a function of frequency

1.3. GLOSSARY OF MULTIPLIER TERMS

1. Analogue multiplier

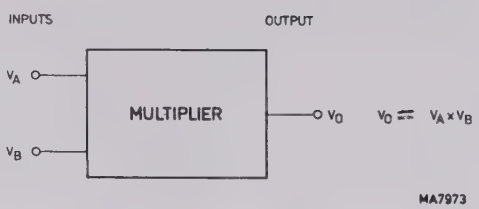


Fig. 1.3. Analogue multiplier

An analogue multiplier is a non-linear device which produces an output voltage that is proportional to the algebraic product of two input voltages.

2. Multiplier bandwidth

The multiplier bandwidth is the frequency range between DC and the upper-frequency-limit at which the multiplier output is 3 dB down with respect to the output at a given low frequency.
This bandwidth is specified by a constant amplitude sine-wave with variable frequency applied to one input and a DC voltage to the other.

3. Multiplier rise-time

The multiplier rise-time is the response time of the swing when a step voltage is applied to one input and a DC voltage to the other.
This time is measured between the 10 % and 90 % points of the step response.

4. Four quadrant operation

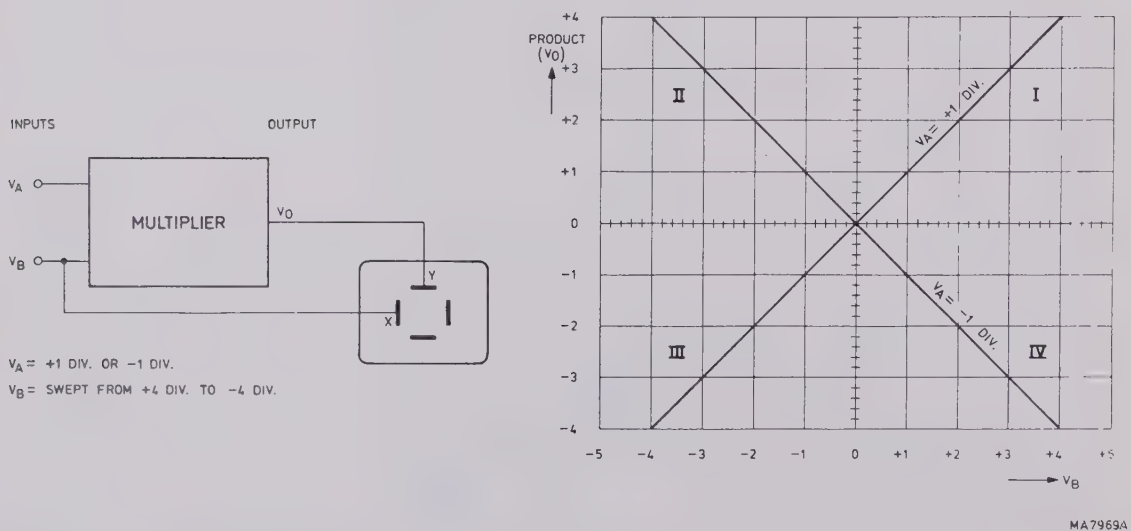


Fig. 1.4. Four quadrant operation

A four-quadrant multiplier can produce an output signal in any of the four quadrants (marked I to IV) of the Cartesian co-ordinate system.

5. Input off-set

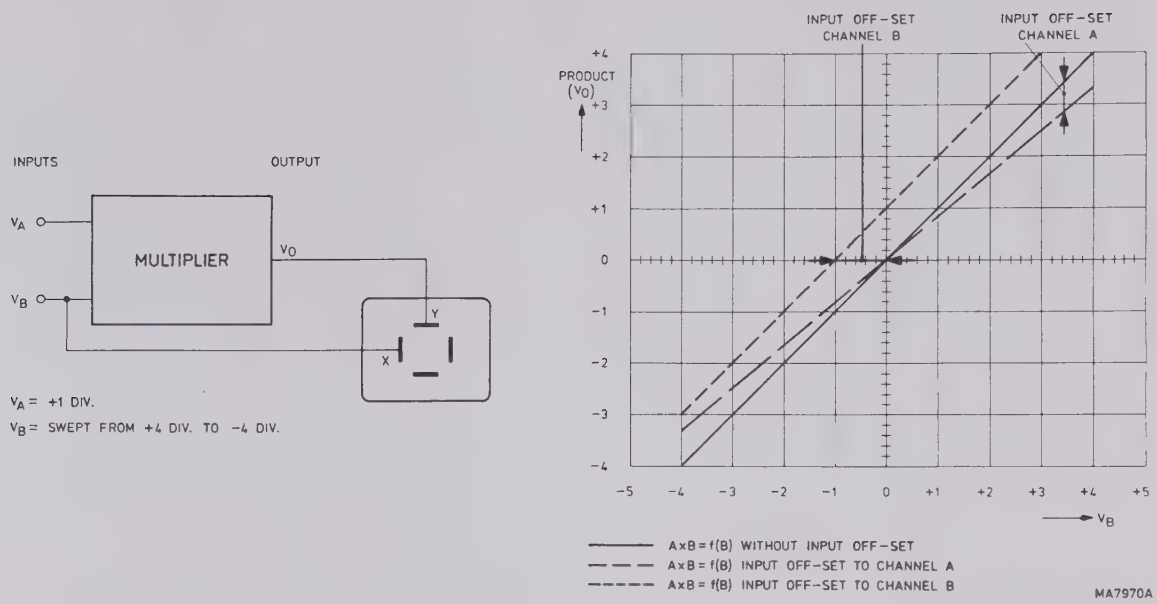


Fig. 1.5. Input off-set

The input off-set is the virtual voltage at the multiplier input when no input signal is applied. This off-set can be minimized by applying a DC balance voltage.

6. Output off-set

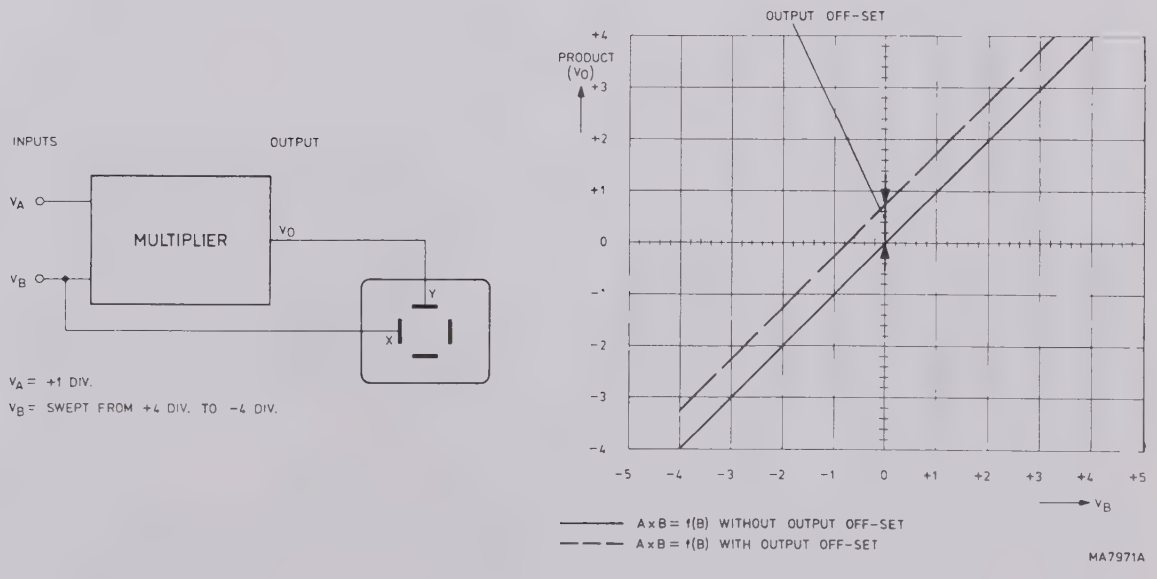


Fig. 1.6. Output off-set

Output off-set is the unwanted voltage at the multiplier output when both input signals are zero. This output off-set is visible as a vertical shift of the displayed product.

7. Scale factor

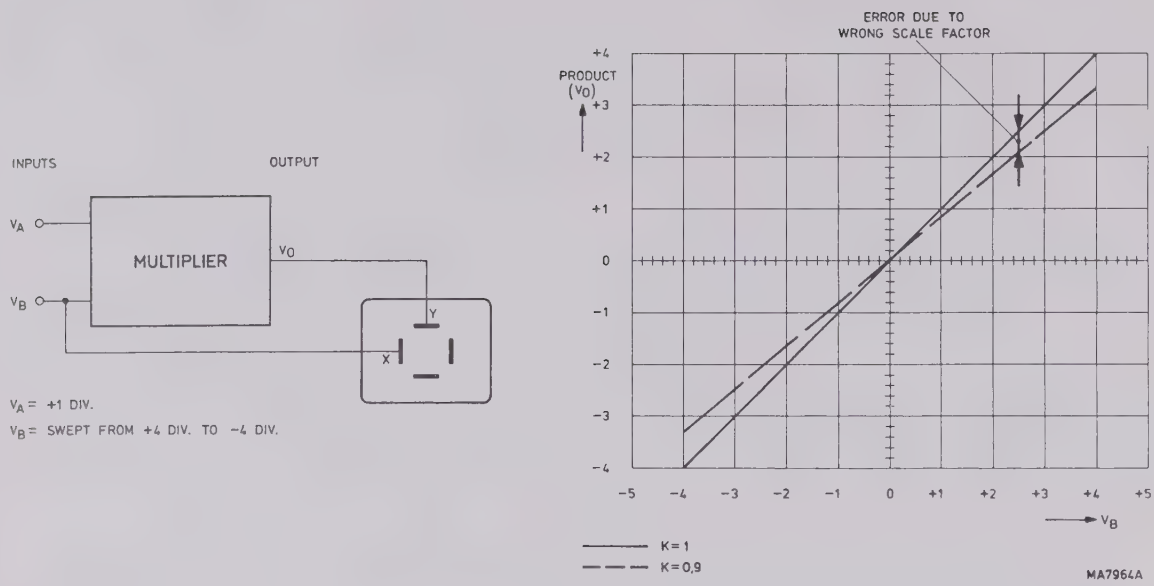


Fig. 1.7. Scale factor

The scale factor K is the constant of proportionality that relates the C.R.T. deflection to the inputs A and B in the MULT. mode.

8. Non-linearity

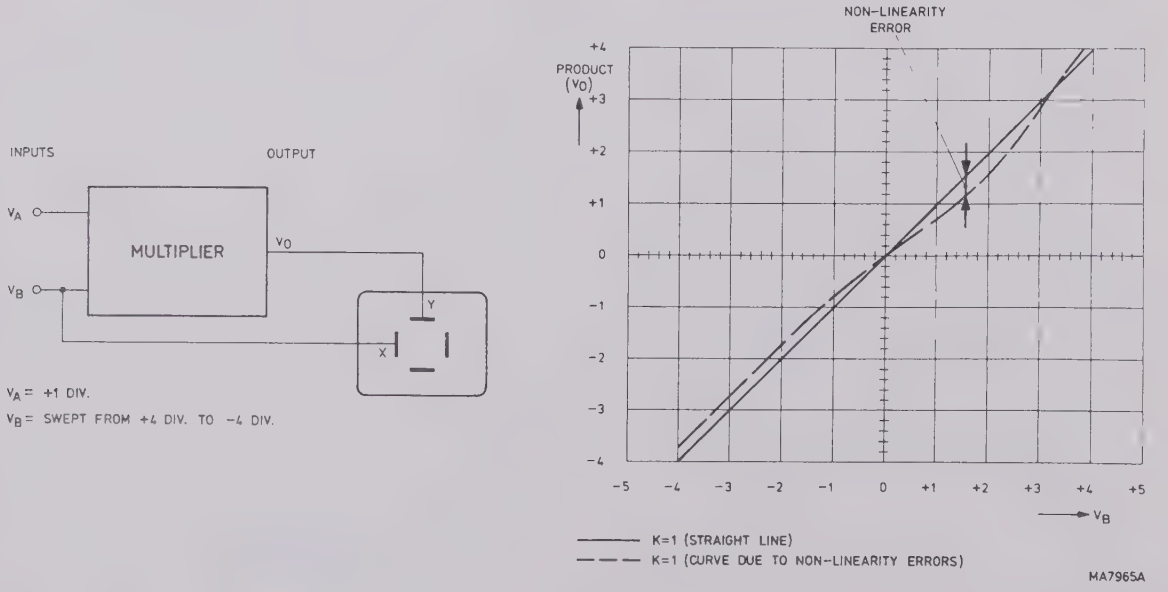


Fig. 1.8. Non-linearity

Non-linearity is the peak deviation of (AxB) = f(B) from the best straight line. It is expressed as a percentage of full screen deflection.

9. Feed-through

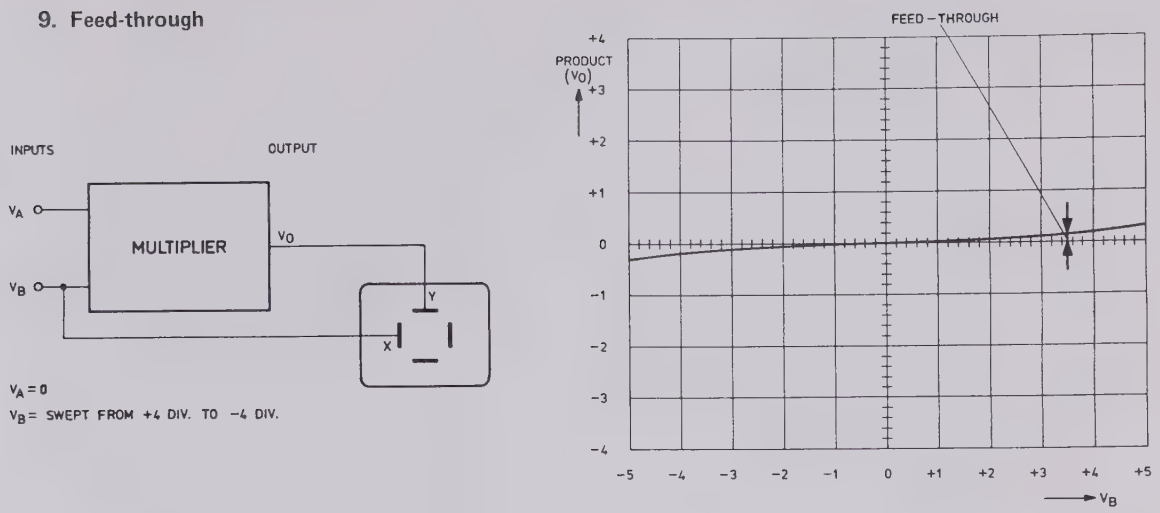


Fig. 1.9. Feed-through

Feed-through is the AC voltage at the multiplier output when after input off-set balancing, one input is held at zero and a maximum signal is applied to the other.

10. Propagation delay

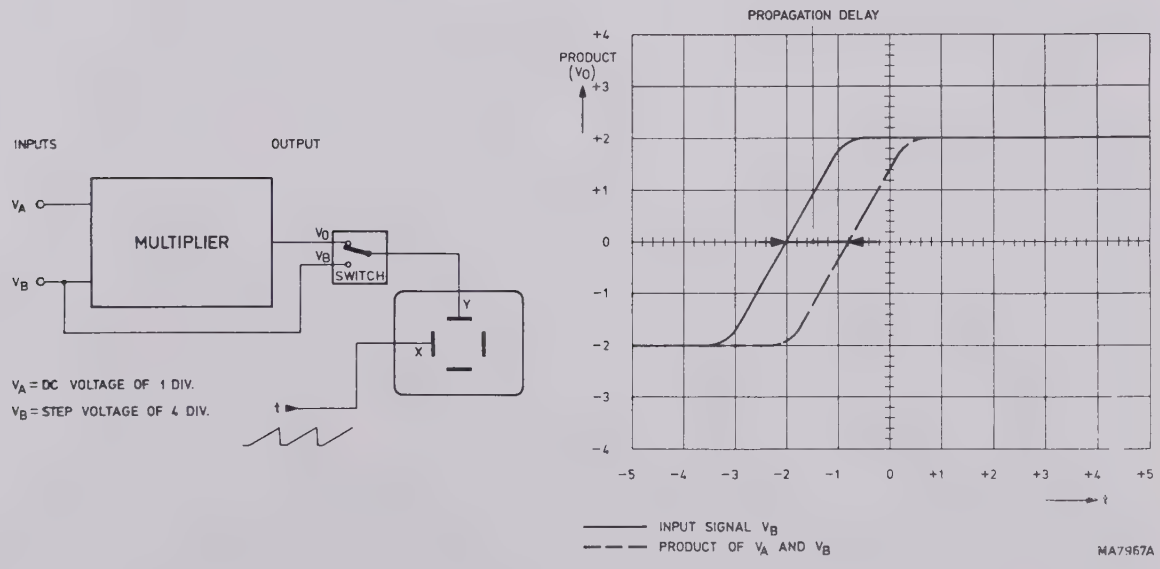


Fig. 1.10. Propagation delay

The propagation delay is the delay between input and output signals caused by the multiplier in processing the input signals.

11. Noise

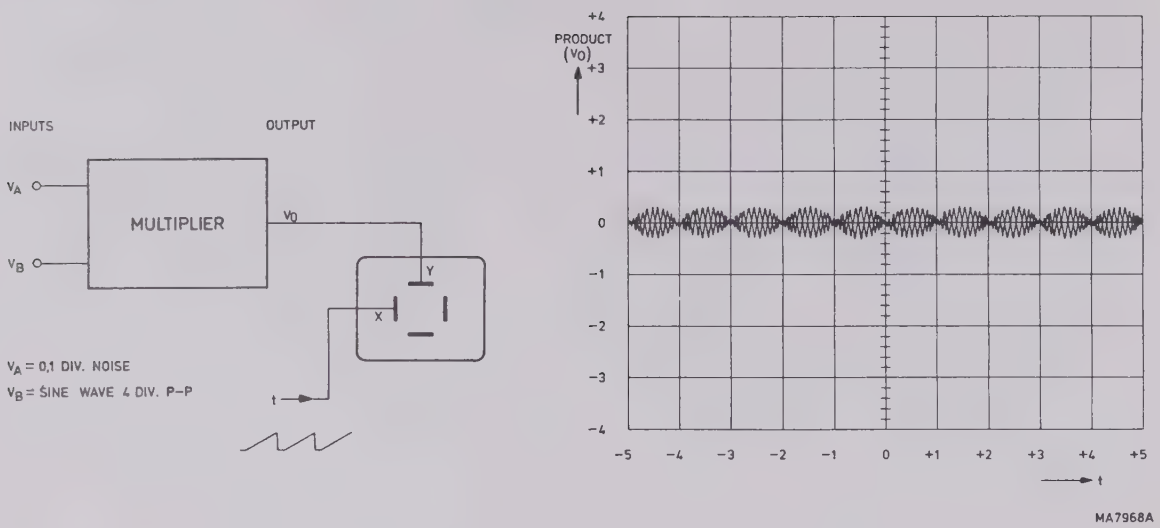


Fig. 1.11. Noise

The multiplier circuit produces no appreciable noise. However, an input voltage of A divisions at one channel will multiply the noise present at the other channel.
This can cause modulation and thus a corrugated base line.

12. Input dynamic range

The maximum signal which can be applied to inputs A and B without impairing linearity.

13. Output dynamic range

The maximum signal which can occur at the output without impairing linearity.

2. Direction for use

2.1. INSTALLATION

Front cover

Removing : — Turn the knob in the centre of the cover a quarter of a turn anti-clockwise to the UNLOCKED position.
Lift off the cover.

Fitting : — Align the key of the front cover locking knob with the slot in the text plate of the instrument.
— Fit the cover over the front of the oscilloscope.
Press and turn the locking knob a quarter of a turn clockwise to the LOCKED position.

The room in the front cover is available to accommodate accessories such as probes, collapsible viewing hood and so on.
To open the front cover press both tongues of the locking device and lift the inner plate.

The **carrying handle** can be rotated by depressing the pushbuttons located on its pivots.

Warning: Before any connection is made to the instrument, the protective earth terminal shall be connected to a protective conductor (see section EARTHING).
This instrument generates high voltages and should not be operated with the cabinet covers removed.
The mains plug must be removed before attempting any maintenance work.

Line voltage and fuse

The ability of the instrument to operate at any line voltage between 90 V and 264 V a.c. or between 100 V and 200 V d.c. obviates the need of adaption to the local line voltage.
The 2 A, delayed action fuse, which is located on the rear panel, is suited for all line voltages. The use of repaired fuses and the short-circuiting of the fuse holder is dangerous and should be avoided.

Earthing

Before switching on, the instrument shall be connected to a protective earth conductor in one of the following ways:
Via the protective earth terminal at the rear (identified by the symbol ⏚) or via the three-core mains lead, provided that the supply socket is equipped with an earth connection.
The protective action must not be negated by the use of an extension cable without a protective conductor.

Warning: Any interruption of the protective conductor, either inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited. When an instrument is transferred from a cold to a warm environment condensation may cause a hazardous condition. Therefore, ensure that the earthing requirements are strictly observed.

Switching on

The POWER switch is incorporated in the front panel INTENS control, immediately below the screen bezel.

CAUTION
EXTENDED HIGH INTENSITY MAY DAMAGE THE CRT

In the "Variable Persistence" mode of operation, the CRT itself warns against too high an intensity by "blooming". When "blooming" occurs, intensity should be reduced by turning the INTENSity knob slightly anti-clockwise.
In the MEMORY OFF position and the X-Y mode of operation, no warning is indicated, therefore special care must be observed.

Fig. 2.1 Removing the front cover

Fig. 2.2. Opening the front cover

2.2. FUNCTION OF THE CONTROLS AND CONNECTORS

Vertical deflection

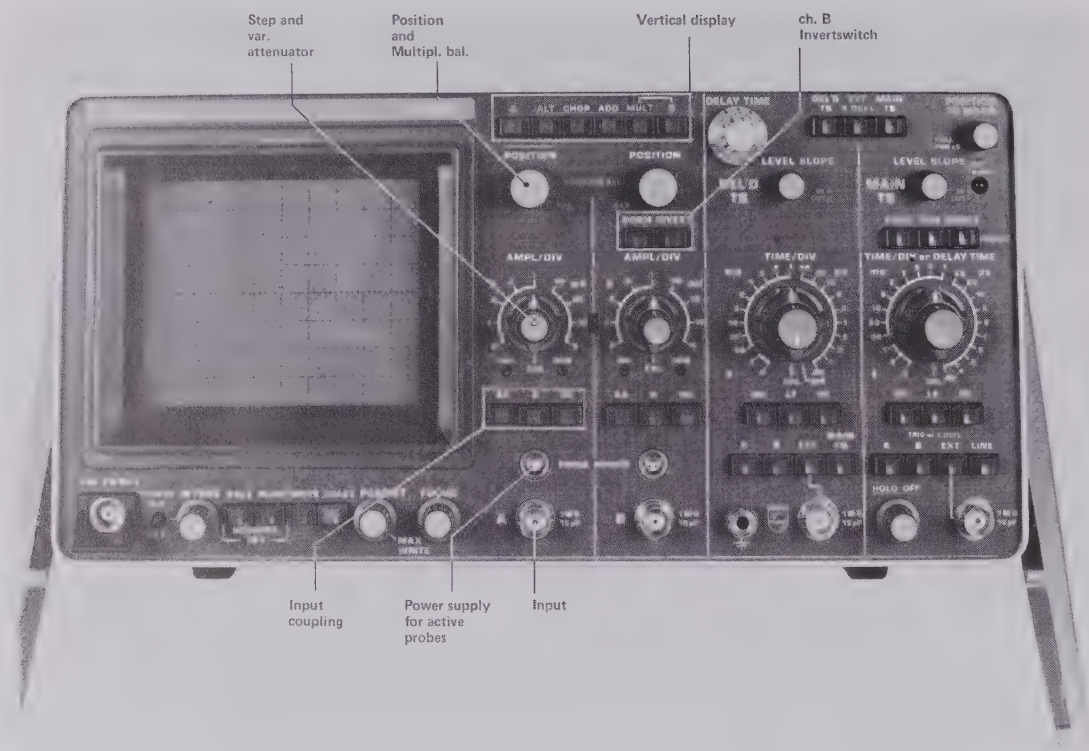


Fig. 2.3. Vertical deflection

Vertical display switch	Display-mode controls; 6-way pushbutton switch.
A depressed	Vertical deflection is achieved by the signal connected to the input of channel A.
ALT depressed	The display is switched over from one vertical channel to the other at the end of every cycle of the time-base.
CHOP depressed	The display is switched rapidly between one vertical channel and the other at a fixed frequency.
ADD depressed	Vertical deflection is achieved by the sum signal of channels A and B.
MULT depressed	Vertical deflection is achieved by the product signal of channels A and B.
B depressed	Vertical deflection is achieved by the signal connected to the input of channel B. If no pushbutton is depressed, the instrument operates in the A mode.
MULT + B depressed simultaneously	The display is switched between MULT and B (CHOP mode).
POSITION and MULTIPL. BAL. (o x A or B)	Continuous variable control giving vertical shift of the display. PUSH FOR BALANCE facility for Multiplier balance (off-set compensations).
NORM/INVERT	2-way pushbutton switch for the inversion of the B signal polarity. Neither pushbutton depressed has the same effect as the NORM button depressed.
AMPL/DIV	Step control of the vertical deflection coefficients; 9-way switch.
AMPL/CAL	Continuously variable control of the vertical deflection coefficients. In the CAL position the deflection coefficient is calibrated.

BAL (screwdriver operated)	Pre-set control of the direct voltage balance of the vertical amplifiers.
GAIN (screwdriver operated)	Pre-set control of the gain-calibration of the vertical channels.
AC/0/DC	Signal coupling; 3-way pushbutton switch.
AC depressed	Coupling via a blocking capacitor.
0 depressed	Connection between input circuit and input socket is interrupted and the amplifier input is earthed.
DC depressed	Direct coupling. No button depressed has the same effect as the AC button depressed.
A 1 MOhm - 15 pF	BNC input socket for channel A.
B 1 MOhm - 15 pF	BNC input socket for channel B.

Horizontal deflection

Fig. 2.4. Horizontal deflection

Horizontale display mode	Horizontal deflection controls; 4-way pushbutton switch.
MAIN TB depressed	The horizontal deflection voltage is supplied by the main time-base generator. A part of the trace is intensified (except in position OFF of the TIME/DIV switch of the delayed time-base generator). No button depressed has the same effect as the MAIN TB button depressed.
EXT. X DEFL depressed	Horizontal deflection is achieved by an external signal applied to the input socket of the horizontal amplifier, by the channel A signal, by the channel B signal, an external signal or by a mains frequency signal.
DEL'D TB depressed	The horizontal deflection voltage is supplied by the delayed time-base generator.
TRIG or EXT X DEFL	If the instrument is used in the timebase mode, the main time-base can be triggered by: A — Signal taken internally from channel A B — Signal taken internally from channel B EXT — Signal applied to the trigger input LINE — Line voltage (mains) internally connected
POSITION TB MAGN	Continuously variable control giving horizontal shift of the display; incorporates a push-pull switch which increases the horizontal deflection coefficient by a factor of 5. The magnifier is inoperative if an external X deflection signal is used.

Main time-base

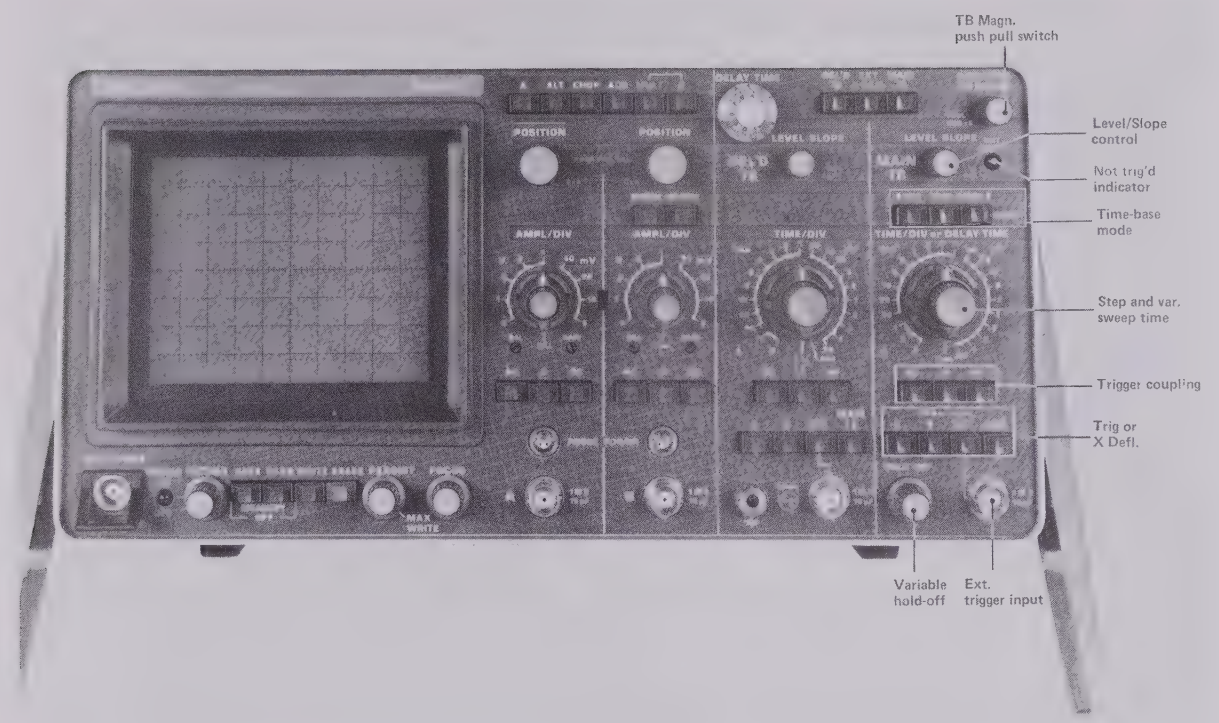


Fig. 2.5. Main time-base

LEVEL SLOPE	Continuously variable control to select the level of the triggering signal at which the time-base starts. This control incorporates a push-pull switch which enables choice of triggering either on the positive or negative-going edge of the triggering signal.
NOT TRIG'D	Pilot light that lights up when the time-base is not triggered; i.e. in the waiting position.
AUTO/TRIG/SINGLE	Trigger-mode controls; 3-way pushbutton switch.
AUTO depressed	The main time-base generator is free-running in the absence of triggering signals.
TRIG depressed	The time-base is normally triggered.
SINGLE depressed	After operating the SINGLE button, the time-base generator runs only once upon receipt of a trigger pulse. If no button is depressed, the instrument operates in the SINGLE mode. If no display is obtained when the instrument is switched on, and an input signal has been connected, check that the AUTO or TRIG modes have been selected for the main time-base.
TIME/DIV or DELAY TIME	Time-coefficient control of the main time-base; 23-way rotary switch.
TIME/DIV CAL	Continuously variable control of the time coefficient of the main time-base. In the CAL position the time coefficient is calibrated.
DC/LF/HF	Trigger coupling; 3-way pushbutton switch.
DC depressed	Triggering signals are direct coupled.

LF depressed	Coupling via low-pass filter for frequencies up to 50 kHz (for external triggering via band-pass filter of 10 Hz to 50 kHz).
HF depressed	Coupling via a high-pass filter for frequencies higher than 50 kHz. No pushbuttons depressed has the same effect as button DC depressed.
TRIG or X DEFL	Trigger source or external X deflection selector; 4-way pushbutton.
A depressed	Internal triggering or X deflection signal derived from channel A.
B depressed	Internal triggering or X deflection signal derived from channel B.
EXT depressed	Triggering on external-signal connected to the adjacent 1 MOhm-15 pF socket. When the EXT X DEFL button of the horizontal deflection controls is depressed, this socket is connected to the input of the horizontal amplifier.
LINE depressed	Triggering or X deflection signal derived from an internal voltage at mains frequency. No button depressed has the same effect as button A depressed.
1 MOhm - 15 pF	BNC socket for external triggering or horizontal deflection.

Delayed time-base

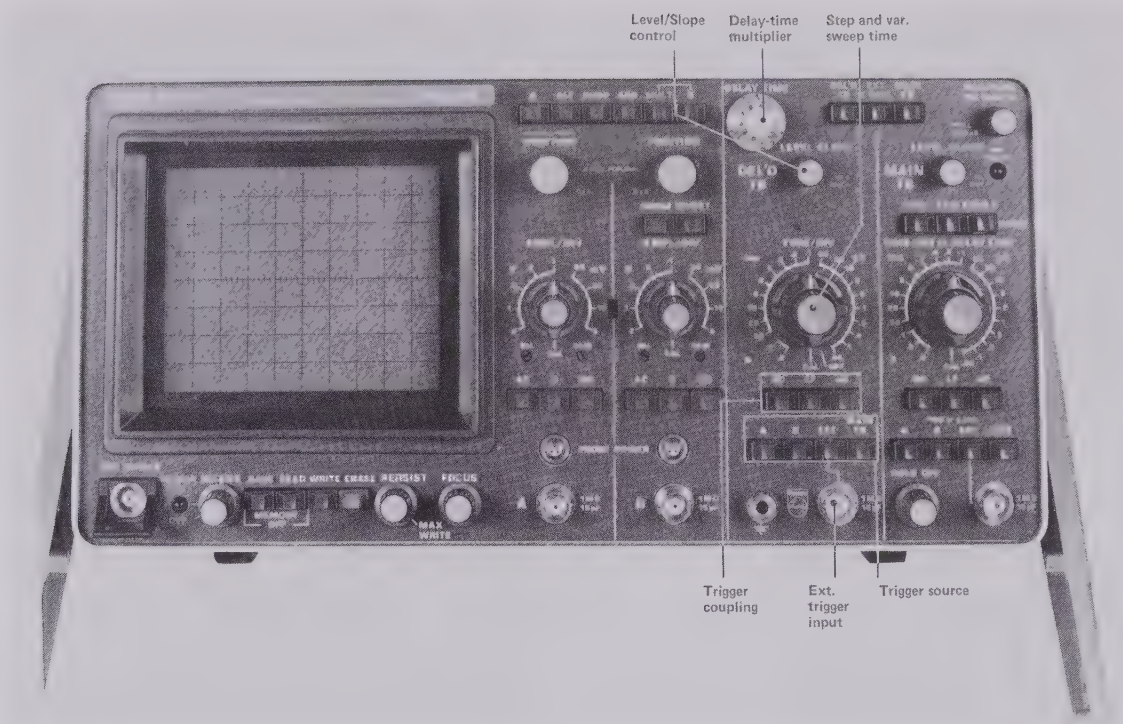


Fig. 2.6. Delayed time-base

DELAY TIME	Calibrated continuously variable control of the delay time, operating in conjunction with the TIME/DIV controls of the main time-base generator.
LEVEL SLOPE	Continuously variable control to select the level of the triggering signal at which the delayed time-base generator starts. This control incorporates a push-pull switch which enables choice of triggering on the positive or negative-going slope of the triggering signal.
TIME/DIV	Time-coefficient control of the delayed time-base; 22-way rotary switch. Incorporates OFF position in which the delayed time-base generator is switched off.
TIME/DIV CAL	Continuously variable control of the time coefficient of the delayed time-base generator. In the CAL position the time coefficient is calibrated.
DC/LF/HF	Trigger coupling; 3-way pushbutton switch.
DC depressed	Trigger signals are direct-coupled.
LF depressed	Coupling via low-pass filter for frequencies up to 50 kHz (for external triggering via band-pass filter of 10 Hz to 50 kHz).
HF depressed	Coupling via a high-pass filter for frequencies higher than 50 kHz. No button depressed has the same effect as the DC button depressed.
A/B/EXT/MAIN TB	Trigger source and starting point of the delayed time-base; 4-way pushbutton switch.
A depressed	Triggerable, after delay time, on channel A signal.
B depressed	Triggerable, after delay time, on channel B signal.
EXT depressed	Triggerable, after delay time, on an external signal connected to the adjacent 1 MOhm - 15 pF socket.
MAIN TB depressed	Delayed time-base starts immediately after delay time.
1 MOhm - 15 pF	BNC input socket for external triggering signal.

CRT Section

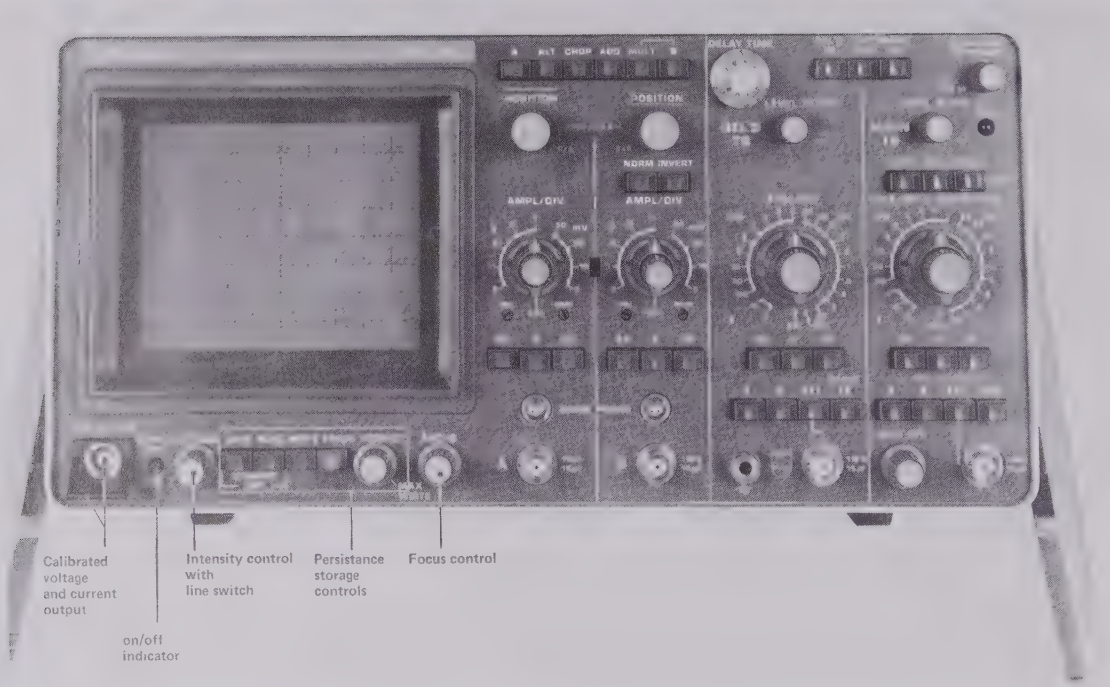


Fig. 2.7. CRT Section

CAL	Output socket on which a 3 $V_{p\text{-}p}$ square wave voltage to calibrate AMPL. control, and frequency response of voltage divider probes. Current loop with 6 $mA_{p\text{-}p}$ current for calibration of current probes.
POWER ON/OFF	Pilot lamp indicates the ON state of the instrument.
INTENS	Continuously variable control of the display-brightness, combined with power on-off switch.
FOCUS	Continuously variable control of the electron beam focusing.
Storage/Persistence controls	
SAVE/READ/WRITE/ERASE	Waveform storage facility; 4-way pushbutton switch.
SAVE	Enables recorded waveform to be stored for a longer time (protected against accidental erasure).
READ	Enables recorded waveform to be observed (protected against accidental erasure).
MEMORY OFF (SAVE + READ)	Allows operation of the instrument without memory.
WRITE	Enables waveform to be recorded; in this mode PERSISTENCE control is operative.
ERASE	Enables erasure of the display in the WRITE mode. If the time base is in the SINGLE sweep mode this switch also resets the time base.

Rear panel

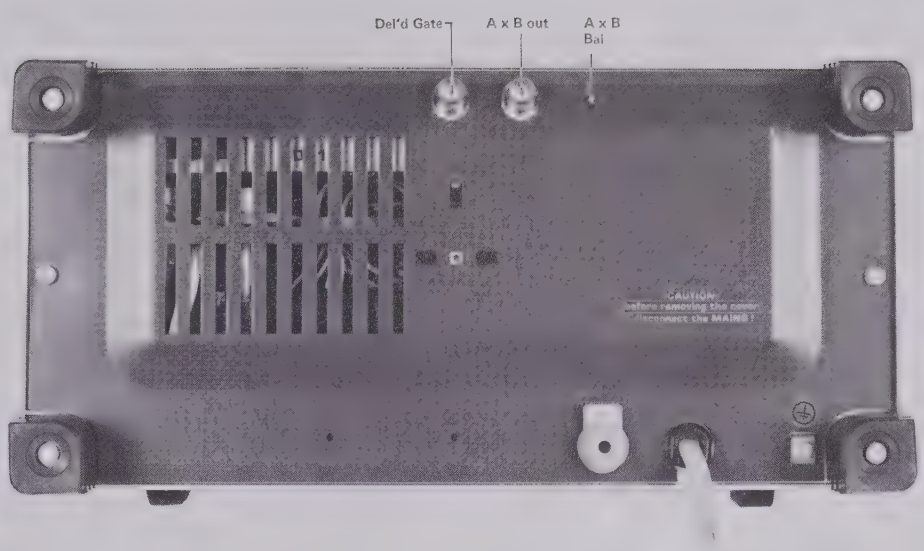


Fig. 2.8. Rear panel.

DEL'D GATE	Delayed time base gate output; TTL compatible. Logic "1" during main time base intensified and delayed time base running times. For Multiplier application.
A x B OUT	D.C. coupled non-integrated multiplier output.
A x B BAL	Multiplier output balance off-set compensation.
FUSE	2 A delayed action for all voltages.
Line cord with plug. Safety earth terminal.	

2.3. PRELIMINARY SETTINGS

Before measurements with this instrument are carried out, checking and adjusting of the following functions may be necessary:
- Step attenuator balance
- Gain calibration
- Multiplier balance (0 x A, 0 x B)
- Multiplier output balance

As the first two settings are identical for both vertical channels, only the procedure for channel A has been indicated.

1. Step attenuator balance

- Depress the MAIN TB button of the horizontal deflection mode switch.
- Depress the AUTO button of the main time-base mode switch.
- Set the INTENSITY and FOCUS controls for a sharp, well-defined trace.
- Depress the relevant channel button of the vertical deflection mode switch.
- Depress the 0 button of the input coupling switch.
- Set the POSITION knob so that the trace is somewhere about in the centre of the screen.
- Set the AMPL. continuous control to position CAL.
- Check that the trace does not jump when the AMPL. switch knob is rotated.
  If necessary adjust the BAL control.

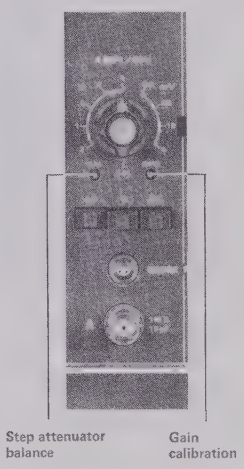


Fig. 2.9.

2. Gain calibration

Unless otherwise stated, the controls occupy the same positions as in the previous procedure.
- Set the AC-0-DC switch to AC.
- Set the AMPL. switch knob to .5 V and the continuous control to CAL.
- Connect the channel input to the CAL output.
- Check the vertical deflection is exactly 6 divisions.
  If necessary adjust the GAIN control.
- Also an attenuator probe can be included in this calibration.
  The probe attenuation factor must then be taken into account with respect to the AMPL. switch position.

3. Multiplier balance 0 x A, 0 x B

When either A or B is multiplied by 0 (zero), the product must be zero. Offset voltages at the multiplier inputs may still cause some deflection on the screen; these offset voltages must be reduced to a minimum by the following procedure:

Remark: The 0 x A and 0 x B controls are operated by pushing the POSITION knobs.

- Allow a warm-up time of at least 15 min, preferably 30 min.
- Apply an a.c. signal with an amplitude within the specified dynamic range to both input A and input B.
- Depress pushbutton MULT of the display-mode controls.
- Depress pushbutton 0 of the channel A signal coupling controls.
- Depress pushbutton AC of the channel B signal coupling controls.
- Minimize the deflection by means of the 0 x B potentiometer without changing the attenuator setting.
- Depress pushbutton AC of the channel A signal coupling controls.
- Depress pushbutton 0 of the channel B signal coupling controls.
- Minimize the deflection by means of the 0 x A potentiometer without changing the attenuator setting.

4. A x B output balance

When using the A x B output at the rear panel, the output must be zero if both inputs are zero.
This can be compensated by the A x B BAL control located near this output.
Proceed as follows:
- check the 0 x A and 0 x B adjustment as indicated under point 3.
- Depress both 0 switches of the ch. A and B inputs.
- Adjust the A x B BAL control unless the A x B output voltage is zero.

2.4. OPERATING INSTRUCTIONS

General

Before switching-on, ensure that the oscilloscope has been correctly installed in accordance to the INSTALLATION recommendations (Chapter 2.1.) and the precautions outlined have been observed.
To use the instrument as an ordinary oscilloscope; i.e. without the storage facility, depress the SAVE and READ pushbuttons simultaneously (MEMORY OFF).

Warning: Do not use a too high intensity in the EXT X DEFL. mode

Inputs A and B and their possibilities

The oscilloscope has been provided with two identical channels, each of which can be used for either YT measurements in combination with one or both time-base generators, or XY measurements in combination with the external horizontal channel.

YT measurements

To display one signal, either of the two vertical channels can be selected by operating either pushbutton A or pushbutton B of the display-mode controls.
When pushbutton ALT or CHOP is depressed, two different signals can be displayed simultaneously. The Y deflection coefficient can be selected for each channel individually. When the ALT button is depressed, the display is switched over from one channel to the other at the flyback of the time-base signal.
Although the ALTERNATE mode can be used at all sweep speeds of the time-base generator, the CHOPPED mode will give a better display quality for long sweep times, because during these long sweep times the alternate display of the two input signals would be clearly visible to the eye.
In the CHOPPED mode, the display is switched over from one channel to the other at a fixed frequency.
If pushbutton ADDed of the display-mode switch is depressed, the signal voltages of both vertical channels are added. Depending on the position of the channel B polarity switch, either the sum or the difference of the input signals is displayed.

XY measurements

If pushbutton EXT X DEFL of the horizontal deflection control is operated, the time-base generators are switched off. A signal applied to the A channel is then used for horizontal deflection, if button A of the TRIG or X DEFL switch is operated.
The AC/0/DC switch and the step attenuator of channel A remain operative.
Continuous control of the deflection coefficients is possible with the continuous control AMPL and horizontal trace shift with the X POSITION control.
Vertical channel B may also be used for X deflection. In this event, the B button of the TRIG or X DEFL controls is depressed.
It is also possible to use an internal voltage at the line frequency or a signal applied to the EXT socket at the bottom right-hand side of the front panel for X deflection, after pressing the relevant pushbutton of the TRIG or X DEFL controls.

AC/0/DC switch

The signals under observation are fed to input sockets A and/or B, the AC/0/DC switch being set to either AC or DC depending on the composition of the signal. As the vertical amplifier is d.c. coupled, the full bandwidth of the instrument is available and d.c. components are displayed as trace shifts in the DC position of the AC/0/DC switch.
This may be inconvenient when small signals superimposed on high d.c. voltages must be displayed. Any attenuation of the signal will also result in attenuation of the small a.c. component. The remedy is to use the AC position of input switch, which employs a blocking capacitor, to suppress the d.c. component. Some pulse drop, however, will occur when LF square-wave signals are displayed.
The 0 position interrupts the signal and earths the amplifier input for a rapid check on the 0 V level.

Using the Multiplier

The signals to be multiplied must be applied to input sockets A and B.

Dynamic range

Both multiplicants A and B must be within the dynamic range of the multiplier and preamplifier circuits. As an overload condition for these circuits may not be noticed in the displayed product, care must be taken to keep each of the input signals within the specified dynamic range, allowing for a maximum amplitude of 8 $div_{p\text{-}p}$.

For the displayed product again a maximum of 8 $div_{p\text{-}p}$ is specified. If the output maximum is exceeded, one of the input signals must be reduced in amplitude.

Multiplier output level

The multiplier output signal is displayed via the A channel. The displayed product with normally have a d.c. component. Therefore, it is important to know the zero level of the displayed product. The d.c. zero line can be shifted to the most convenient place on the screen by means of the channel A POSITION control if the 0 pushbutton of the signal-coupling control has been depressed.

Using the persistance/storage facility

Starting from the MEMORY OFF position (SAVE and READ pushbuttons simultaneously depressed), with the INTENSity and FOCUS controls set for a sharply-defined trace, the PERSISTENCE/STORAGE mode of operation can be obtained by depressing the pushbutton, WRITE.

The functions of the other controls are then as follows:

PERSIST	Depending on the position of the PERSISTence potentiometer, a rapidly vanishing trace will be written on a green background (knob completely anti-clockwise) or a slowly vanishing trace on a black background (knob on its first clockwise stop). The persistence can be set to suppress any flickering when displaying a low-frequency signal. For a signal with a low repetition rate and a short rise-time, the persistence can be set to fill-up the trace to obtain a clear, steady display.
SAVE	If a particular display needs to be retained, is can be saved by depressing the SAVE button. The display is then just visible.
READ	The intensity of the stored display increases by depressing the READ button, but brightness is achieved at the expense of storage time.
ERASE	When de display is no longer needed it can be erased by depressing the ERASE button. Any persistence of the trace, especially those parts written with substantial brightness, can be removed by prolonged operation of the ERASE button.
MAX WRITE	The writing speed can be increased by a factor of 10 (approx.) by rotating the PERSISTence control to its second clockwise stop (MAX WRITE), so that the incorporated switch is operated. The MAX WRITE mode of operation is required for short sweep times or for signals with a short rise-time.

Triggering

If a signal must be displayed, the horizontal deflection must always be started on one fixed point of the signal to obtain a stationary display. The time-base generator is, therefore, started by narrow trigger pulses formed in the trigger unit and controlled by a signal originating from one of the vertical input signals, an internal voltage at mains frequency or an external source.

Trigger coupling

Three different trigger-coupling methods can be chosen with the DC/LF/HF switch. In the HF and LF positions, the transfer characteristic is limited.
In position DC the trigger signal is passed unchanged. In position LF, a d.c. (10 Hz for external triggering) to 50 kHz band-pass filter is inserted. This position can be used to reduce interference from noise. In position HF, a 50 kHz high-pass filter is inserted. This position can be used to reduce intereference from e.g. hum.

Selecting the trigger source and setting the trigger level

The trigger signal is obtained from channel A (button A depressed), channel B (button B depressed), an external source (button EXT depressed) or from an internal voltage at mains frequency (button LINE depressed).
The trigger pulse shaper is a multivibrator switched by the output signal of the trigger amplifier.
The trigger signal together with direct voltages which are adjustable with the LEVEL potentiometer, fed to the input of the trigger amplifier.
Depending on the LEVEL setting, a certain part of the trigger signal will be amplified by this amplifier.
The multivibrator is thus switched at a fixed point of the trigger signal.
This means that, with the aid of the LEVEL control, it is possible to scan the shape of the trigger signal (in case of internal triggering A or B equal to the shape of the signal to be displayed) and, thus, to choose the point where the multivibrator will be switched.
The LEVEL potentiometer is fitted with a push-pull switch which allows selection of the trigger slope.

Automatic triggering

When the AUTOmatic button of the AUTO/TRIG/SINGLE switch is depressed, and if there are no trigger pulses available, the time-base generator is automatically free-running.
The trace is, therefore, always visible. The AUTOmatic mode can be used in all cases where the TRIG mode is also usable, except with signal frequencies lower than 10 Hz or pulse trains with an off time exceeding 100 ms. As soon as trigger pulses are available, the free-running state of the time-base generator is automatically terminated and the time-base generator is triggered again.
When the TRIGgered or SINGLE button is depressed, the auto-circuit is switched off.
The LEVEL setting can also be used in the AUTOmatic mode.

SINGLE sweep triggering

When effects that occur only once have to be observed (usually photographed), it is desirable to ensure that only one sawtooth is generated, even though several trigger pulses might be produced after the phenomenon of interest. Naturally, the single sawtooth in question must be triggered by a trigger pulse, therefore, the SINGLE button must be pressed. The first trigger pulse that appears after the button has been released will start the time-base generator.
The time-base generator is then blocked until the SINGLE pushbutton is again depressed.
The NOT TRIG'D lamp will light up as soon as the SINGLE button has been released, until a further trigger pulse arrives.
Note that also the ERASE button resets the time base in the single sweep mode.

Time-base MAGNifier

The time-base magnifier is operated by a push-pull switch incorporated in the horizontal POSITION control. If this switch is pulled to position x5, the sweep speeds of the main time-base generator are increased by a factor of 5. Thus the portion of the signal displayed over a width equal to two divisions in the centre of the screen in the x1 position (TB MAGN depressed), will occupy the full width of the screen in the x5 position. Any portion of the trace can be brought on to the screen by the horizontal POSITION control for observation. In the x5 position, the time coefficient is determined by dividing the indicated TIME/DIV value by 5.

Use of the delayed time-base

If the MAIN TB button of the horizontal display switched is depressed, and the delayed time-base TIME/DIV knob is not in the OFF position, part of the main time-base sweep line is displayed at higher intensity.
In this way, part of the displayed signal can be selected for more detailed observation. The selected part of the signal is displayed over the whole screen by pressing the DEL'D TB switch.
The sweep time of the intensified part of the main-time-base sweep depends on the delayed time-base TIME/DIV knob.
With the centre knob, sweep times between the steps can be adjusted. For time measurements this knob must always be in the CAL position.

The starting time of the delayed time-base is determined by the settings of the main time-base TIME/DIV or DELAY TIME 10-turn multiplier knob.

If the MAIN TB trigger selector switch of the delayed time-base is pressed, the delay time after which the delayed time-base is started, is the product of the main time-base TIME/DIV switch setting and the DELAY TIME multiplier knob.

If instead of MAIN TB, the delayed time-base is triggered by A, B or EXT, the delayed time-base will start after this delay-time and upon receipt of a trigger pulse. This trigger pulse is supplied by the trigger unit of the delayed time-base generator. This position is used when time jitter would otherwise give a blurred image of the detail under observation. This time jitter could be part of the signal being investigated or, at extreme magnifications, originate in the time-base circuits.

Gerätehandbuch

1. Allgemeines

1.1. EINLEITUNG

Der tragbare 50 MHz Speicher und Multiplikator Oszillograf gestattet Messung, Speicherung und Multiplikation von Signalen bei hoher (5 mV/Teil) Empfindlichkeit.

Das Gerät bietet vielseitige Darstellungsarten, wie Einkanalbetrieb, zwei Kanäle alternierend oder gechopped, zwei Kanäle addiert mit normaler oder invertierter Lage für ein Kanal B Eingangssignal, Multiplikation zweier Kanäle, eine Hauptzeitablenkung und eine verzögerte Zeitablenkung.

Der Oszillograf PM 3243 besitzt eine Speisung mit geringer Verlustleistung.
Die Speisung ist bei jeder beliebigen Wechselspannung zwischen 90 V und 264 V oder bei jeder beliebigen Gleichspannung zwischen 100 V und 200 V betriebsfähig, wodurch sich Einstellung des Geräts für das örtliche Netz erübrigt. Durch alle diese Eigenschaften eignet sich der PM 3243 für grosse Fülle von Anwendungen.

Merkmale

Zusammenfassend, kennzeichnen folgende Eigenschaften den Oszillograf PM 3243:
- 5 mV Empfindlichkeit bei 50 MHz
- Eingebauter 40 MHz Multiplikator
- Gleichzeitige Darstellung des Produkts und eines der Faktoren
- Variable Nachleuchtdauer und Speicherung
- Fortschrittliche Konstruktion
- Sehr leistungsfähige Speiseeinheit die über einen weiten Bereich von Wechsel- oder Gleichspannung, ohne dass dabei Spannungumschaltung erforderlich ist, betrieben werden kann.

Bemerkung: Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben etwas abweichen.

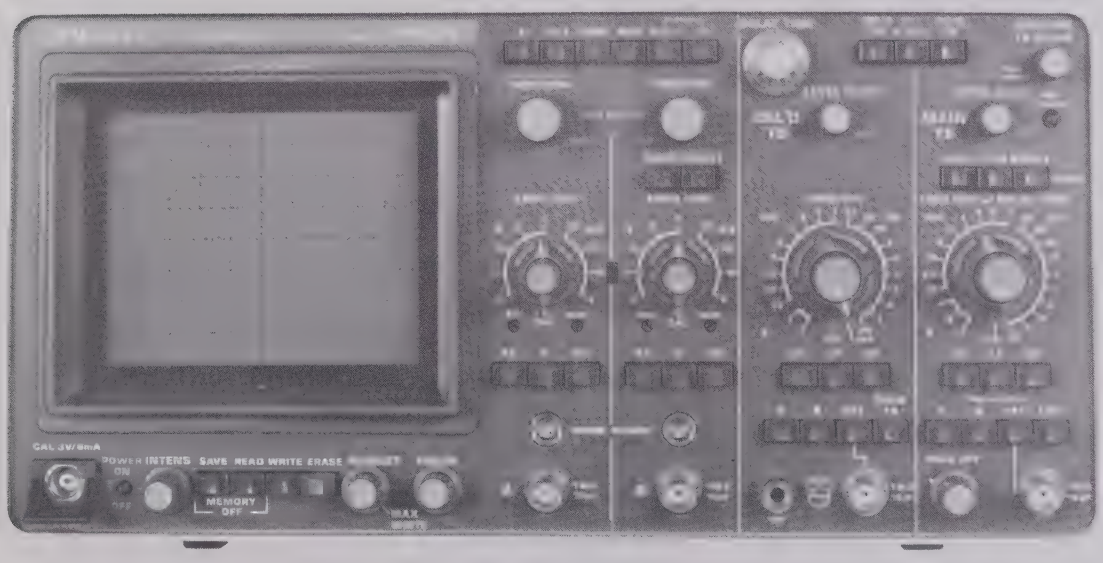


Fig. 1.1. PM 3243

1.2. TECHNISCHE DATEN

Allgemeine Hinweise:

Dieses Gerät ist gemäss IEC 348, Sicherheitsbestimmungen für elektrische Mess- und Regeleinrichtungen, gebaut und geprüft und hat das Werk in sicherheitstechnisch einwandfreien Zustand verlassen. Um diesen Zustand zu erhalten und einen gefahrlosen Betrieb sicherzustellen, muss der Anwender die Hinweise und Warnvermerke beachten, die in dem vorliegenden Gerätehandbuch enthalten sind.

Nur Angaben mit Toleranzen oder Grenzwerten können als garantierte Daten angesehen werden. Daten ohne Toleranzen, d.h. ohne Fehlergrenzen, sind informative Daten und werden nicht garantiert.

Fehlerangaben gelten nach einer Anwärmzeit von 30 minuten nach dem Einschalten.

Prozentuale und absolute Fehler sind auf den jeweils angegebenen Referenzwert bezogen.

Bennenung	*Beschreibung*	*Nähere Angaben*
Elektronenstrahlröhre		
Typ	89L14GH/55	Rechteckschirm, Nachbeschleuniger Halbtonspeicherröhre
Nutzbare Bildschirmfläche	8 x 10 Teile	1 Teil = 0,9 cm
Schrimtyp	P31, Phosphor	
Gesamtbeschleunigungsspannung	8,5 kV	
Raster	Intern	
Nachleuchtdauer		
Normal	Eigennachleuchtdauer von Phosphorleuchtschirm P31	(10 µs . . . 1 ms)
Variabel	Kontinuierlich variabel von 0,3 s bis 1,5 min.	
Speicherzeit		
Bei Betriebsart "WRITE" (max. Nachleuchtdauer)	1,5 min.	
Bei Betriebsart "READ"	3 min.	
Bei Betriebsart "SAVE"	15 min.	
Schreibgeschwindigkeit		
Normal	0,2 Teil/µs	
Betriebsart "MAX. WRITE"	2 Teile/µs	
Löschen	Drucktaste betätigt Löschzeit ca. 800 ms	
Vertikale oder Y-Achse		
Anzahle Kanäle	2	
Darstellungsarten	Kanal A allein Kanal B allein A und B gechopped A und B alternierend A und B addiert A x B multipliziert A x B und B, gechopped Die Polarität von Kanal B kann invertiert werden	
Chopperfrequenz	1 MHz	
Darstellungszeit pro Kanal in	ca. 500 ns	
Bandbreite	DC . . . 50 MHz	Gleichspannungskopplung Obere Bandbreitebegrenzung –3 dB

Benennung	*Beschreibung*	*Nähere Angaben*
	10 Hz . . . 50 MHz	Wechselspannungskopplung –3 dB Bandbreitebegrenzung
Anstiegszeit	7 ns	
Ablenkkoeffizienten	5 mV/Teil . . . 2 V/Teil	Neun kalibrierte Stufen in 1-2-5 Folge Nicht kalibriert, stufenlose Einstellung 1:2,5
Fehlergrenze	± 3 %	
Überschwingen	max. 2 %	
Höchstzulässige Eingangsspannung	± 400 V	Gleichspannung + Spitzenwert einer Wechselspannung
Eingangsimpedanz	1 MΩ//15 pF	
Eingangskopplung	AC-0-DC	
Eingangszeitkonstante	22 ms	AC-Kopplung
Abschwächer Ausgleich	max. 0,2/Teil	Bildverschiebung beim Schalten zwischen einer der Abschwächerstufen, oder bei stufenloser Einstellung
Instabilität des Leuchtflecks	max. 0,05 Teil/Stunde max. 0,01 Teil/°C	 +10 °C . . . 40 °C
Dynamischer Bereich	24 Teile max. 6 Teile	15 MHz, Sinussignale 50 MHz, Sinussignale
Verschiebungsbereich	16 Teile	
Übersprechen zwischen Kanäle A und B	40 dB	gechopped oder alternierend (DC . . . 50 MHz)
Max. gesamte Eingangssignal Amplitude bei A minus B	24x Abschwächereinstellung	
Multiplikator		
Bandbreite	DC - 40 MHz	–3 dB Obere Bandbreite begrenzung Bandbreite des Multiplikators gemessen mit einem Sinussignal im einen Kanal und einem Gleichspannungssignal im anderen
Darstellungsarten	A x B A x B und B	+ oder – B + oder – B, gechopped
Anstiegszeit	9 ns	
Masstabfaktor	1 ± 2 %	Bezogen auf die Bildhöhe von entweder Faktor oder Produkt
Dynamischer Bereich		
Signal A oder B Signal A x B	8 Teile 8 Teile	(± 4 Teile ab Schirmmitte) (± 4 Teile ab Schirmmitte)
Linearitätsfehler	± 4 % der Schirmhöhe	
Übersprechen	0,2 Teile	–30 dB
Produkt-Offset	max. 0,2 Teile	
Produkt-Offset-Drift	max. 0,03 Teil/°C	
Fortpflanzungsverzögerung	max. 8 ns	
Ausgang	BNC-Anschluss auf der Rückseite des Geräts	gleichspannungsgekoppelt

Benennung	*Beschreibung*	*Nähere Angaben*
Massstabskoeffizient	100 mV/Teil ± 4 % 50 mV/Teil ± 5 %	Belastung 10 kΩ Belastung 50 Ω innerhalb des dynamischen Bereichs
Impulsabweichung	5 %	
Ausgangs-Offset	max. 10 mV	Belastung 10 kΩ, extern regelbar
Ausgangsdrift	3 mV/°C	Belastung 10 kΩ

Horizontale oder X-Achse

Horizontalablenkung wird entweder von der Hauptzeitbasis oder von der verzögerten Zeitbasis, von einer Kombination dieser beiden, oder von der für X-Ablenkung gewählten Signalquelle erlangt. In letzterem Fall können X-Y Oszillogramme dargestellt werden, wobei als Signalquelle für Horizontalablenkung Kanäle A oder B, der Stecker EXT oder das Netz verwendet werden.

Darstellungsarten	Hauptzeitablenkung Hauptzeitablenkung verstärkt durch verzögerte Zeitablenkung Verzögerte Zeitablenkung X-Y Betrieb	 über Y_A, Y_B, extern oder Netz

Horizontalverstärker

Bandbreite	DC . . . 1 MHz über 6 Teile (–3 dB obere Grenze)
Ablenkkoeffizient	450 mV/Teil über Stecker EXT Vertikalabschwächer Koeffizienten sind zutreffend wenn Y_A oder Y_B für X-Ablenkung verwendet wird.
Eingangsimpedanz	1 MΩ//15 pF
Messfehler	± 10 % bei Verwendung von Eingang Y_A oder Y_B
Phasenfehler	3 ° bei 100 kHz

Hauptzeitablenkung

Betriebsarten	AUTO - TRIG - SINGLE	
Zeitkoeffizienten	0,5 s/Teil . . . 50 ns/Teil, Folge 1-2-5 Dazwischen stufenlos einstellbar 1:2,5 nicht kalibriert Dehnung x5 erhöht die maximale Ablenkgeschwindigkeit auf 10 ns/Teil	
Sperrschaltung	Die Sperrzeit der Ablenkung kan mindestens um den Faktor 5 vergrössert werden.	
Fehlergrenze	± 3 % Ausgenommen:	 0,5 s und 0,2 s ± 5 % 100 und 50 ns ± 5 % Ablenkgenauigkeit über zwei beliebige Teile der 10 Teile Ablenkung ist ± 5 % Bei den 10 ns/Teil und 20 ns/Teil gedehnten Zeitbalenkgeschwindigkeit das erste und letzte Teil ausschliessen

Verzögerte Zeitablenkung

Die verzögerte Zeitablenkung started sofort nach Verzögerungsintervall oder kann nach dem Verzögerungsintervall durch die gewählte Zeitablenk-Triggerquelle getriggert werden.

Zeitkoeffizienten	0,2 s/Teil . . . 50 ns/Teil, Folge 1-2-5 Dazwischen stufenlos einstellbar 1:2,5 , nicht kalibriert Dehnung 5x erhöht die maximale Ablenkgeschwindigkeit auf 10 ns/Teil	
Fehlergrenze	± 3 % Ausgenommen:	 0,2 s ± 5 % 100 und 50 ns ± 5 %

Benennung	*Beschreibung*	*Nähere Angaben*
		Ablenkgenauigkeit über zwei beliebige Teile der 10 Teile Ablenkung ist ± 5 % Bei den 10 ns/Teil und 20 ns/Teil gedehnten Zeitablenkgeschwindigkeit das erste und letzte Teil ausschliessen.
Ablenkverzögerung	In Stufen, variabel mit Hauptzeitablenkung. Kontinuierlich einstellbar mit 10-Gang-Potentiometer zwischen 0,2x und 10x dem Zeitkoeffizienten der Hauptzeitbasis.	
Verzögerungszeitjitter	1 : 20.000	
Inkrementeller Verzögerungszeitfehler	0,5 %	
Torausgang der verzögerten Zeitablenkung	Steckverbindung an der Rückwand, die während der aufgehelten Hauptzeitablenkung und der verzögerten Zeitablenkung Laufzeiten Logik '1' TTL Ausgangsimpulse liefert. Für Multiplikator Anwendungen	
Triggerung der Hauptzeitablenkung		
Triggerquelle	Intern von Kanal A oder B Extern Netz	
Triggerflanke	+ oder −	
Triggerkopplung (siehe Abb. 1.2)	DC (DC . . . 50 MHz) LF (DC . . . 50 kHz intern - 10 Hz . . . 30 kHz extern) HF (50 kHz . . . 50 MHz) Automatischer Freilauf (Auslösezeit ⩽ 100 ms)	
Empfindlichkeit	Intern < 0,5 Teil (1/3 Teil typisch) Extern < 150 mV (100 mV typisch)	
Pegelbereich	Intern 24 Teile typisch Extern −5 bis +5 V typisch	
Externe Eingangsimpedanz	1 MΩ//15 pF	Gleich dem Y-Eingang
Triggerung der verzögerten Zeitablenkung	Intern von Kanal A oder B Extern Alle anderen Triggerungsdaten entsprechen denen der Hauptzeitablenkung	
Amplituden Kalibrierungseinheit		
Spannung	+ 3 V	Rechteckspannung, Basislinie auf Nullspannung
Strom	6 mA	Rechteckstrom durch Stromschleife
Fehlergrenze	± 1 %	Für Spannung und Strom
Frequenz	2 kHz ± 2 %	
Schutz	Der Ausgang ist kurzschlussicher	
Speisung		
Netzspannungen	Bei jeder beliebigen Spannung zwischen 100 V und 240 V ± 10 % jeder beliebigen Frequenz zwischen 46 und 440 Hz in einem Bereich ohne Umschalten betriebsfähig	
Gleichspannung	Jede beliebige Gleichspannung 100 V und 200 V	
Leistungsaufnahme	39 W	
Messkopfspeisung	Zwei Buchsen liefern +24 V und −24 V für aktive Messköpfe Maximaler Stromverbrauch 2 x 50 mA je Ausgang	

EINFLUSSGRÖSSEN

Die angegeben Daten gelten nur dann, wenn das Gerät gemäss den offizielen Prüfverfahren kontrolliert wurde. Einzelheiten, die dieses Verfahren und die Fehlergrenzenkriterien betreffen, können von der PHILIPS-Organisation Ihres Landes oder von N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPT., EINDHOVEN, HOLLAND angefordert werden.

Umgebungstemperaturen	+5 °C . . . +40 °C	Betrieb innerhalb Spezifikation
	−10 °C . . . +55 °C	Arbeitsbereich
	−40 °C . . . +70 °C	Lagerung und Transport
Höhe	5000 m	Betriebsfähig
	15000 m	nicht Betriebsfähig
Feuchtigkeit	Das Gerät entspricht den Anforderungen gemäss IEC 68 Db Standard	
Stossfestigkeit	1000 Stösse von 10 g, ½ Sinus, Dauer 6 ms, in jeder der 3 Richtungen	
Vibration	30 Minuten in jeder der drei Richtungen, 10-150 Hz; 0,7 mm (Spitze-Spitze) und 5 g maximale Beschleunigung.	
Akklimationszeit	30 Minuten für Normalbetrieb	Kommend von −10°C nach +20°C bei 60 % relativer Feuchtigkeit
Störgrad	Das Gerät entspricht den Anforderungen gemäss VDE Störgrad K.	
Abmessungen und Gewicht	Höhe 154 mm	
	Breite 316 mm	
	Tiefe 460 mm	
	Gewicht 10,6 kg	

Wahlweise Gerätezusätze

Folgende wahlweise zu bestellende Ergänzungen sind erhältlich.
Fordern Sie von Ihrem nächsten Philips Service Stelle nähere Einzelheiten an.
- Hauptzeitablenkungsausgang
- Torausgang der Hauptzeitablenkung
- Ausgang der Verzögerten Zeitablenkung

Mitgeliefertes Zubehör

Zwei passive Messköpfe 1:10
Kontrastfilter
Frontdeckel
Faltbare Nebenlichtblende PM 9366
BNC-Adapter PM 9051
CAL-Anschlussklemme für BNC-Adapter
Bedienungs- und Serviceanleitung

Einige der oben erwähnten Zubehören befinden sich im Innern des Frontdeckels.

Wahlzubehör

PM 9335	Passiver Messkopfsatz 1:1 (1,5 m)
PM 9335L	Passiver Messkopfsatz 1:1 (2,5 m)
PM 9350	50 MHz Passiver Messkopfsatz 10:1 (1,5 m)
PM 9350L	50 MHz Passiver Messkopfsatz 10:1 (2,5 m)
PM 9358	150 MHz Hochspannungsmesskopfsatz 100:1
PM 9347	Aktiver TV-Triggerungsmesskopf
PM 9352	Miniaturmesskopf
PM 9353	Aktiver FET-Messkopf 150 MHz
PM 9355	Strom-Messkopf
PM 8910	Polaroid Anti-Reflexfilter
PM 9380	Oszillografenkamera
PM 8971	Kamera-Adapter
M3 . . . M5	Steinheil Oszillografenreihe
PM 8960	19" Gestelleinbau-Adapter
PM 8980	Langer Lichtschutztubus

PM 8901	Wiederaufladbares Batteriepack 140 V Gleichspannung
PM 8991	Rollwagen
PM 8992	Zubehörbeutel

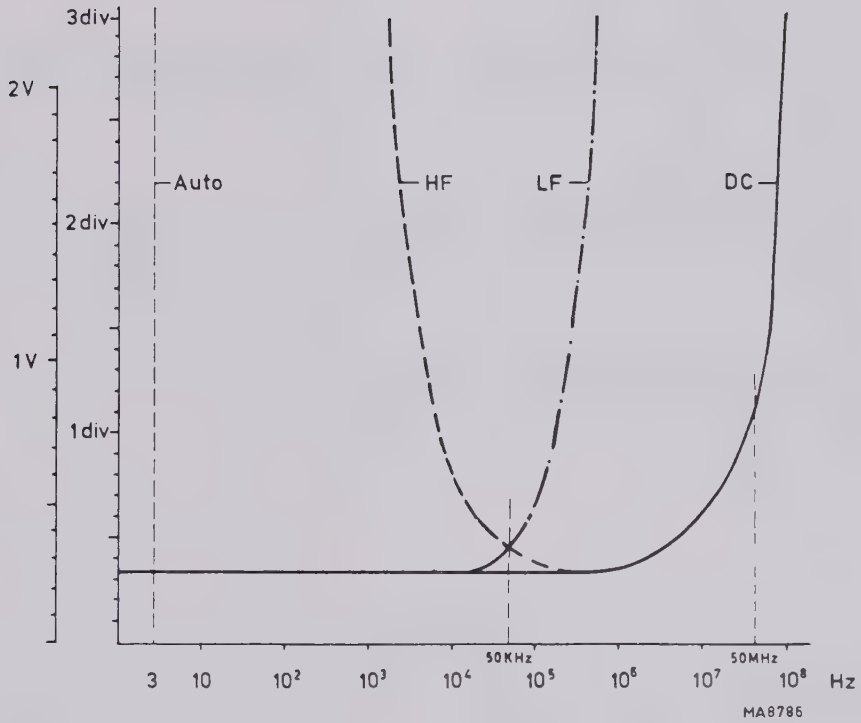


Fig. 1.2. Typische Triggerempfindlichkeit

1.3. VERZEICHNIS VON MULTIPLIKATORAUSDRÜCKEN

1. Analoger Multiplikator

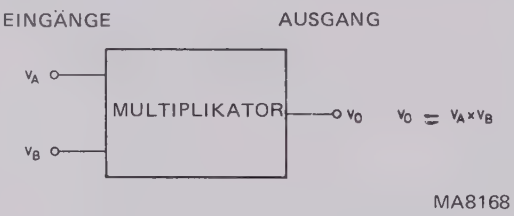


Fig. 1.3. Analogue Multiplikator

Ein analoger Multiplikator ist eine nichtlineare Vorrichtung, die eine Ausgangsspannung abgibt, die dem algebraischer Produkt von zwei Eingangsspannungen proportional ist.

2. Bandbreite des Multiplikators

Die Bandbreite des Multiplikators ist der Frequenzbereich zwischen Null und der oberen Frequenzbereichgrenze bei der die Ausgangsspannung des Multiplikators um 3 dB gegenüber der Ausgangsspannung bei tiefen Frequenzen abgefallen ist. Diese Amplitude wird spezifiziert bei einer konstanten Sinusamplitude mit veränderliche Frequenz an einem Eingang und einer Gleichspannung am anderen.

3. Anstiegszeit des Multiplikators

Die Anstiegszeit des Multiplikators ist die Ansprechzeit der Ausgangsamplitude, wenn an einen Eingang eine Sprungfunktion und an den anderen eine Gleichspannung angeschlossen wird.
Diese Zeit wird zwischen den 10 %- und 90 %-Punkten der Sprungfunktion gemessen.

4. Vier-Quadrantenbetrieb

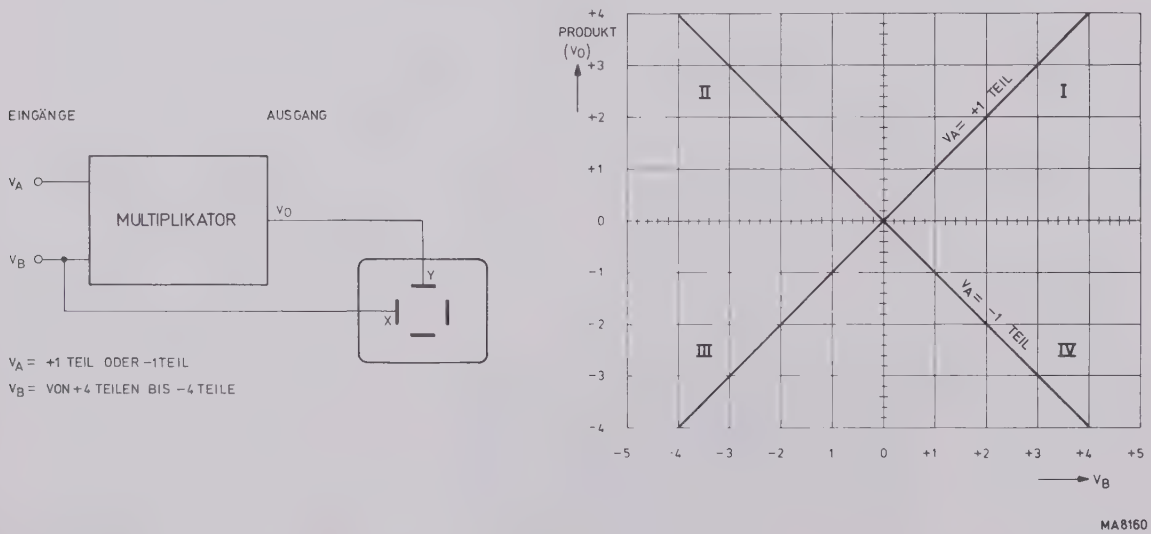


Fig. 1.4. Vier-Quadrantenbetrieb

Ein Vier-Quadranten-Multiplikator kann in jedem der vier Quadranten I bis IV des kartesischen Koordinatensystems ein Ausgangssignal liefern.

5. Eingangsverschiebung (off-set)

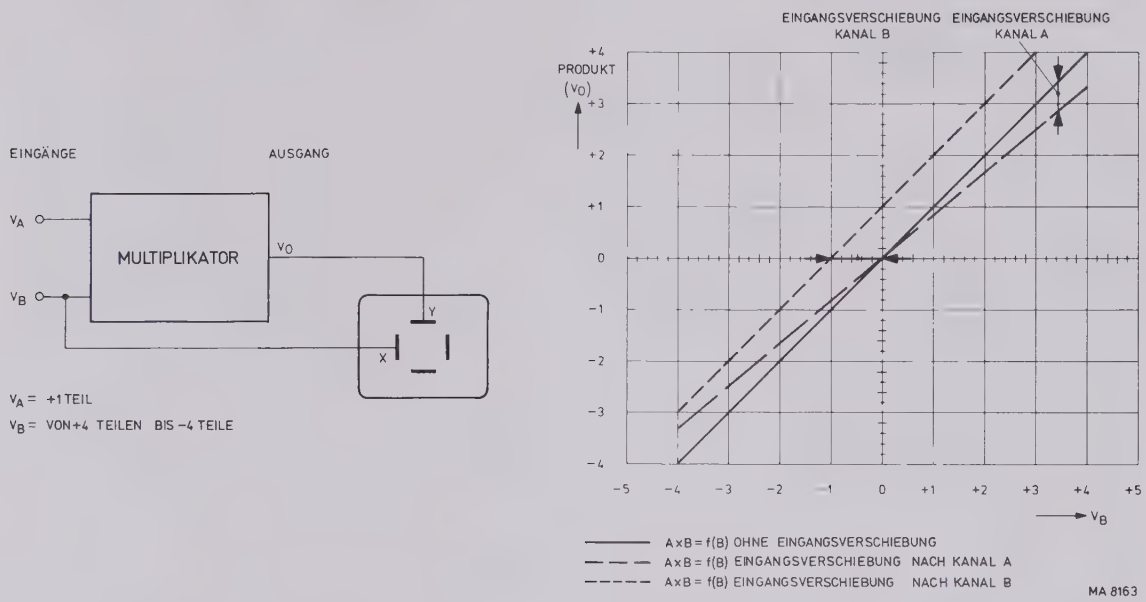


Fig. 1.5. Eingangsverschiebung (off-set)

Die Eingangsverschiebung ist die scheinbare Spannung am Eingang des Multiplikators, wenn kein Eingangssignal anliegt. Dieser Spannung kann durch eine Gliechspannungssymmetrierung entgegengewirkt werden.

6. Ausgangsverschiebung (off-set)

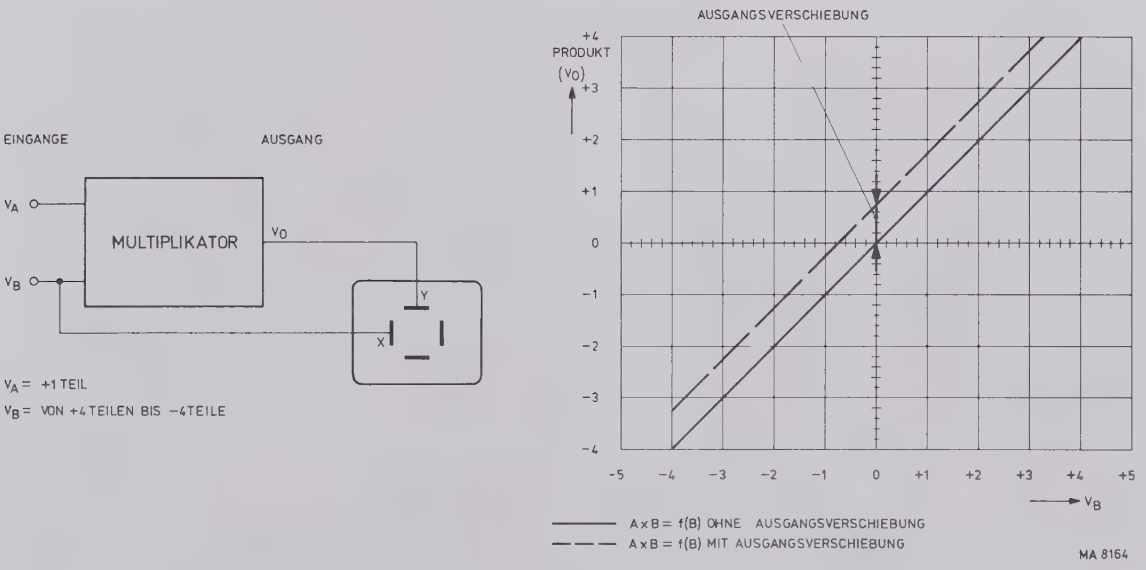


Fig. 1.6. Ausgangsverschiebung (off-set)

Die Verschiebung der Ausgangsspannung ist die unerwünschte Spannung am Ausgang des Multiplikators, wenn beide Eingangssignale Null sind. Diese Spannung ist als Vertikalverschiebung des Produkts sichtbar.

7. Massstabfaktor

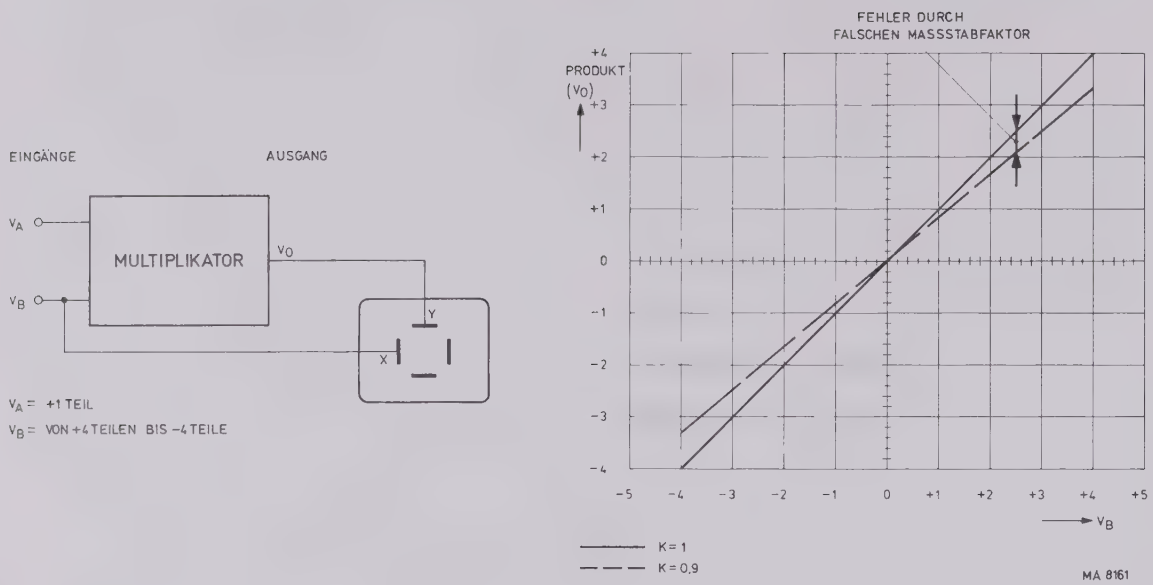


Fig. 1.7. Massstabfaktor

Der Massstabfaktor K ist die Proportionalitätskonstante, die das Verhältnis der Ablenkung der Elektronenstrahlröhre zu den Spannungen an den Eingängen A und B im Multiplikatorbetrieb angibt.

8. Linearitätsfehler

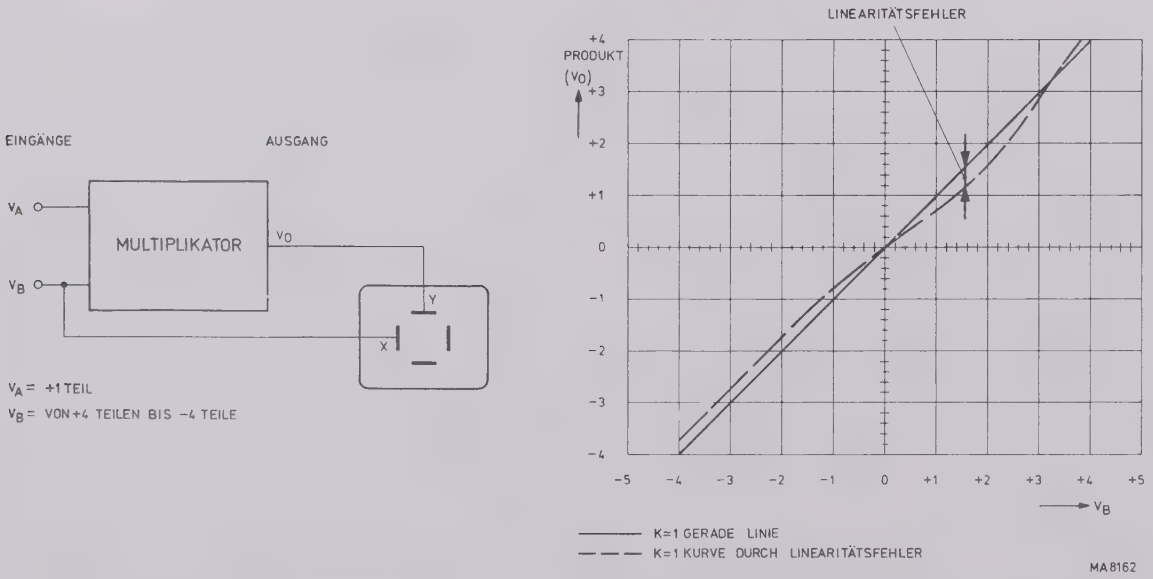


Fig. 1.8. Linearitätsfehler

Der Linearitätsfehler ist die Abweichung, gemessen als Spitzenwert, von (AxB) = f (B) von einer idealen Geraden. Er wird als Prozentsatz der Schirmhöhe angegeben.

9. Übersprechen

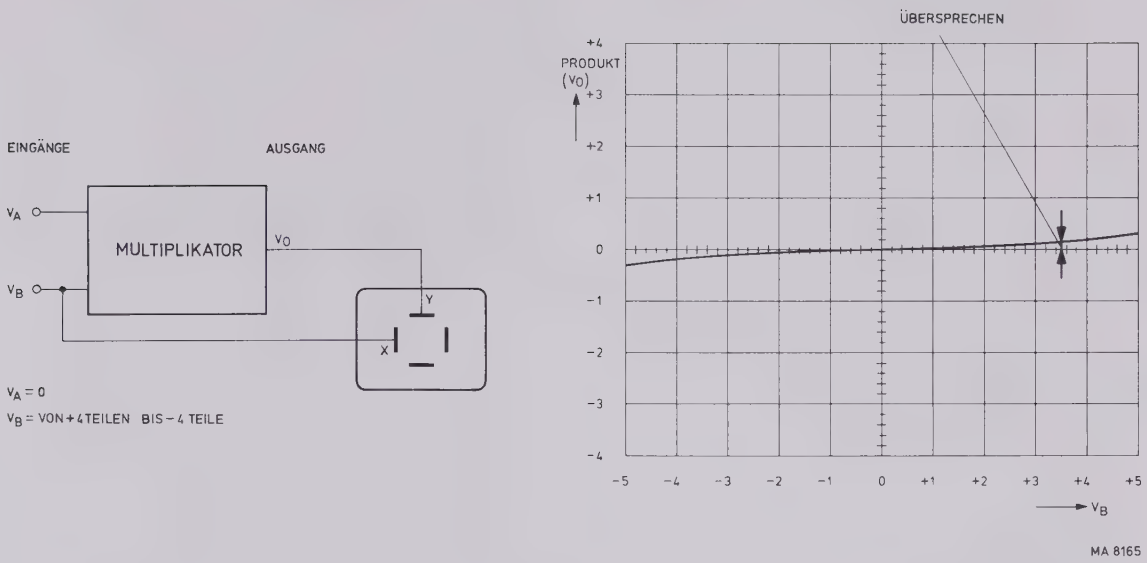


Fig. 1.9. Übersprechen

Das Übersprechen ist diejenige Wechselspannung am Ausgang des Multiplikators, die nach Symmetrierung der Eingangsverschiebung gemessen wird, wenn ein Eingang auf Null gehalten und an den anderen ein maximales Signal angeschlossen wird.

10. Fortpflanzungsverzögerung

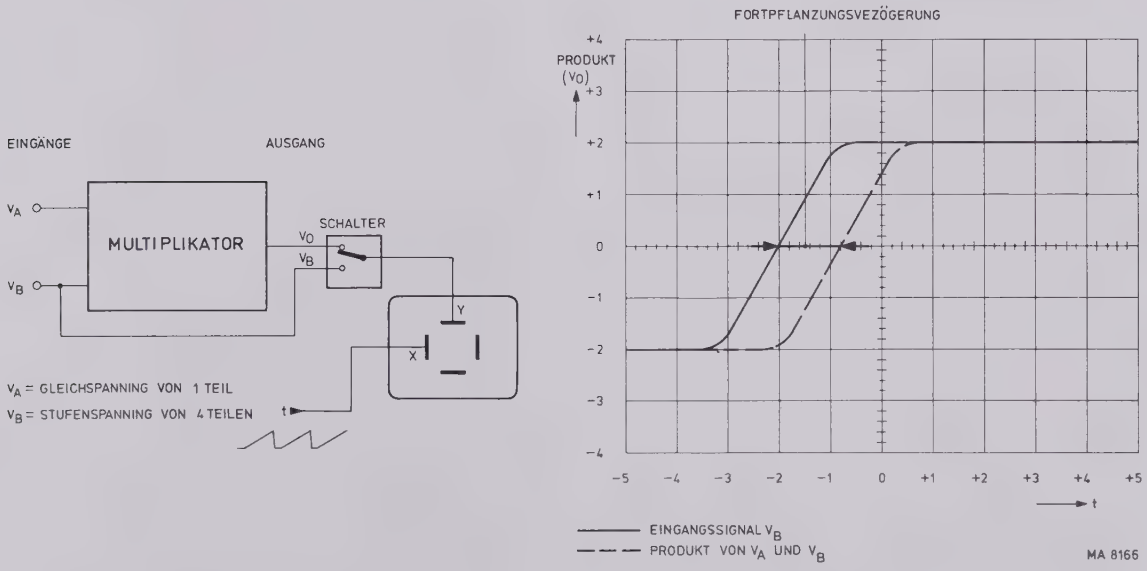


Fig. 1.10. Fortpflanzungsverzögerung

Die Fortpflanzungsverzögerung ist die Verzögerung zwischen den Eingangssignalen und dem Ausgangssignal, die durch die Verarbeitung der Eingangssignale im Multiplikator bedingt ist.

11. Rauschen

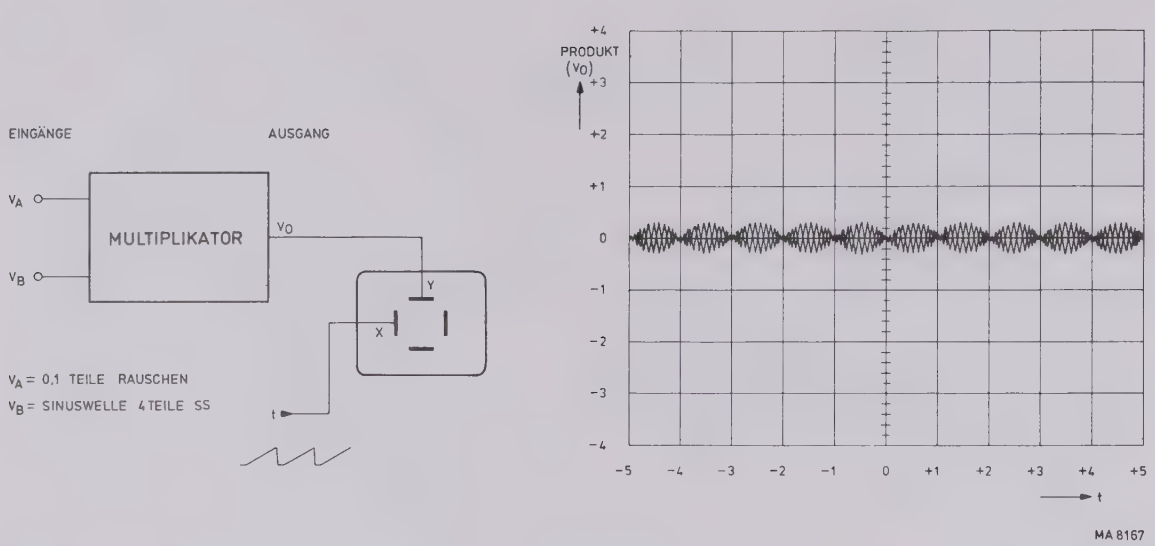


Fig. 1.11. Rauschen

Der Multiplikator erzeugt kein nennenswertes Rauschen. Eine Eingangsspannung von A Teilen des einen Kanals multipliziert sich jedoch mit einem am Eingang des anderen Kanals liegenden Rauschen. Hierdurch kann eine Modulation gebildet werden, die als wellige Nullinie erscheint.

12. Dynamischer Bereich des Eingangs

Das maximale Signal, das den Eingängen A und B zugeführt werden kann, ohne dass die Linearität beeinträchtigt wird.

13. Dynamischer Bereich des Ausgangs

Das maximale Signal am Ausgang, das noch linear wiedergegeben wird.

2. Gebrauchsanleitung

2.1. INBETRIEBNAHME

Frontdeckel

Abnehmen : – Den Knopf in der Mitte des Deckels eine viertel Umdrehung nach links drehen (Stellung UNLOCKED)
– Deckel abnehmen.

Aufsetzen : – Den Verriegelungsknopf in Stellung UNLOCKED drehen.
– Deckel an der Vorderseite des Oszillografen befestigen.
– Knopf eindrücken und eine viertel Umdrehung nach rechts drehen (Stellung LOCKED).

Im Innern des Deckels kann Zubehör wie z.B. Messköpfe, faltbarer Lichtschutztubus usw. aufbewahrt werden. Die Platte im Innern des Deckels lässt sich durch Zusammendrücken der beiden Zungen an der Verrieglungsvorrichtung herausheben (siehe Abb. 2.2).

Der Handgriff lässt sich drehen, wenn die Druckknöpfe auf ihren Lagern eingedrückt werden.

Warnung: Vor Anschluss des Geräts muss die Erdschutzklemme mit einem Schutzleiter verbunden werden (siehe Abschnitt "ERDEN).
In diesem Gerät werden hohe Spannungen erzeugt, deshalb darf es niemals in geöffnetem Zustand eingeschaltet werden.
Vor Wartungsarbeiten ist der Netzstecker zu ziehen und ist darauf zu achten dass alle Hochspannung führenden Teile entladen sind.

Netzspannung und Sicherung

Da das Gerät bei jeder Netzspannung zwischen 90 V und 264 V Wechselspannung oder zwischen 100 V und 200 V Gleichspannung betriebsfähig ist erübrigt sich das Umschalten auf die örtliche Netzspannung.
Die an der Geräterückwand vorhandenen Sicherung von 2 A, träge ist für alle Netzspannungen geeignet.
Verwendung reparierter Sicherungen und das Kurzschliessen des Sicherungshalters ist gefährlich und daher unzulässig.

Erden

Vor dem Einschalten muss das Gerät auf eine der folgenden Arten mit einem Erdschutzleiter verbunden werden.
Aus Sicherheitsgründen muss der Oszillograf entweder über den Erdanschluss an der Rückseite (gekennzeichnet ⏚), oder über das dreiadrige Netzkabel, vorausgesetzt das Gerät wird an eine Schukosteckdose angeschlossen, geerdet werden.
Diese Schutzmassnahme darf nicht unwirksam gemacht werden, z.B. durch eine unvollkommene Verlängerungsleitung !

Warnung: Jede Unterbrechung des Schutzleiters innerhalb oder ausserhalb des Geräts ist aus sicherheitsgründen unzulässig.
Wenn ein Gerät von kalter in warme Umgebung gebracht wird kann Kondensation einen gefährlichen Zustand verursachen. Deshalb ist darauf zu achten dass die Erdungsvorschriften strikt befolgt werden.

Einschalten

Der Schalter POWER ist mit dem Einsteller INTENS gekoppelt und befindet sich an der Vorderseite des Geräts unter dem Bildröhrenrahmen.

WARNUNG

EINE GROSSE HELLIGKEIT ÜBER LÄNGERE ZEIT KANN DIE ELEKTRONENSTRAHLRÖHRE BESCHÄDIGEN

In der Betriebsart PERSIST (Variable Nachleuchtdauer) warnt die Elektronenstrahlröhre selbst durch Leuchtspurzerfliessung vor übermässiger Strahlintensität. Im Falle einer solchen Leuchtspurzerfliessung muss durch geringe Drehung des Knopf INTENS die Helligkeit verringert werden.
In Stellung MEMORY OFF und in Betriebsart X-Y erfolgt keinerlei Warnung, deshalb ist dabei besondere Vorsicht geboten.

Fig. 2.1. Abnehmen des Frontdeckels

Fig. 2.2. Öffnen des Frontdeckels

2.2. FUNKTION DER BEDIENUNGSORGANE UND STECKVERBINDUNGEN

Vertikalablenkung

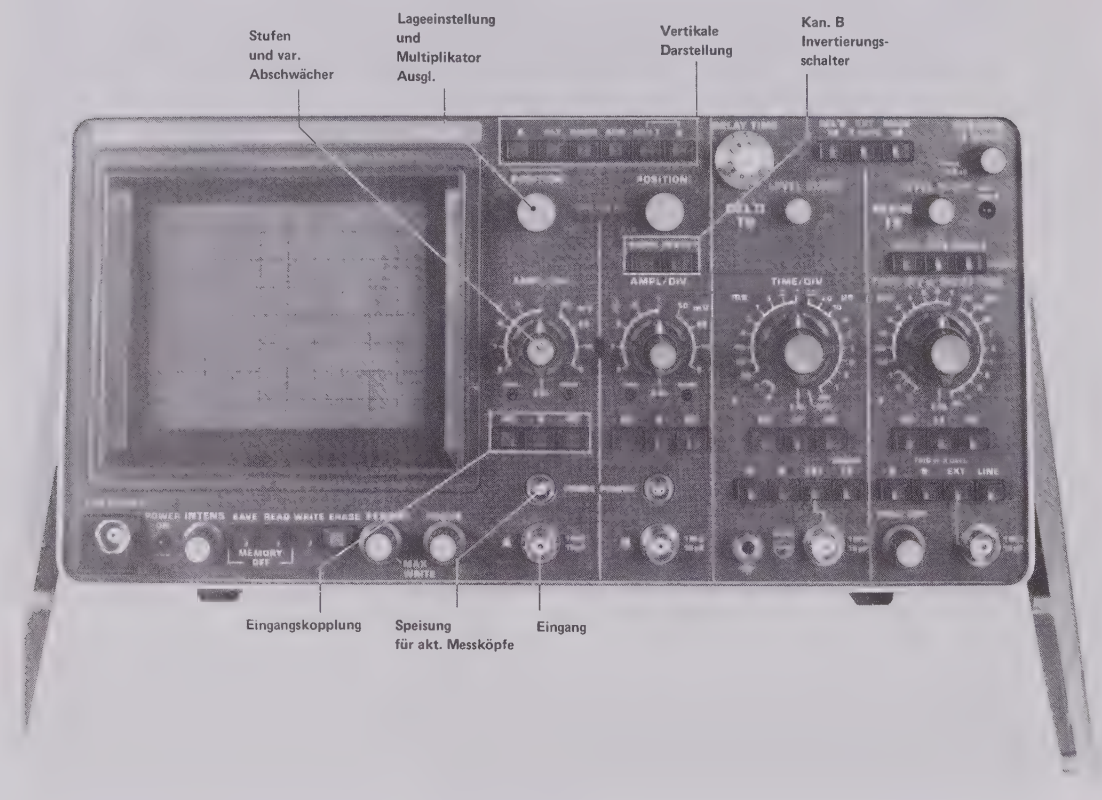


Fig. 2.3. Vertikalablenkung

Vertikaldarstellungsschalter	Einstellung der Darstellungsarten; Drucktastenschalter mit 6 Stellungen
A eingedrückt	Vertikalablenkung durch Anschluss des Signals an den Eingang von Kanal A
ALT eingedrückt	Das Bild wird am Ende jedes Zyklus der der Zeitablenkung von einem Vertikalkanal auf den anderen umgeschaltet.
CHOP eingedrückt	Das Bild wird mit einer Festfrequenz rasch von einem Kanal auf den anderen umgeschaltet.
ADD eingedrückt	Vertikalablenkung durch die Summe der Signale von Kanal A und B.
MULT eingedrückt	Vertikalablenkung durch das Produkt der Signale von Kanal A und B.
B eingedrückt	Vertikalablenkung durch Anschluss des Signals an den Eingang von Kanal B. Wenn keine Taste eingedrückt ist, arbeitet das Gerät in betriebsart A.
MULT + B gleichzeitig gedrückt	Das Bild wird zwischen MULT und B geschaltet (Betriebsart CHOP).
POSITION und MULTIPL. BAL (0 x A oder B)	Stufenlose Einstellung der vertikalen Lage des Bildes. PUSH FOR BALANCE, Einrichtung für Multiplikator-Ausgleich (off-set Ausgleich).
NORM/INVERT	Drucktastenschalter mit 2 Stellungen zur Umkehrung der Signalpolarität Kanal B. Keine der Tasten gedrückt hat die gleiche Wirkung wie Taste NORM gedrückt.
AMPL/DIV	Stufenweise Einstellung der Vertikalablenkkoeffizienten; Wahlschalter mit 9 Stellungen.

AMPL/CAL	Stufenlose Einstellung der Vertikalablenkkoeffizienten. In Stellung CAL ist der Ablenkkoeffizient kalibriert.
BAL (Schraubenziehereinstellung)	Stufenlose Einstellung des Gleichspannungsgleichgewichtes des Vertikalverstärkers.
GAIN (Schraubenziehereinstellung)	Stufenlose Einstellung der Gesamtverstärkung der Vertikalkanäle.
AC/0/DC	Signalkopplung, Drucktastenschalter mit 3 Stellungen.
AC eingedrückt	Kopplung über einen Sperrkondensator
0 eingedrückt	Verbindung zwischen Eingangsschaltung und Eingangsbuchse wird unterbrochen und der Verstärkereingang geerdet.
DC eingedrückt	Direkte Kopplung Ist keine Taste eingedrückt so gilt Einstellung AC.
A 1 MOhm - 15 pF	BNC Eingangsbuchse für Kanal A
B 1 MOhm - 15 pF	BNC Eingangsbuchse für Kanal B

Horizontalablenkung

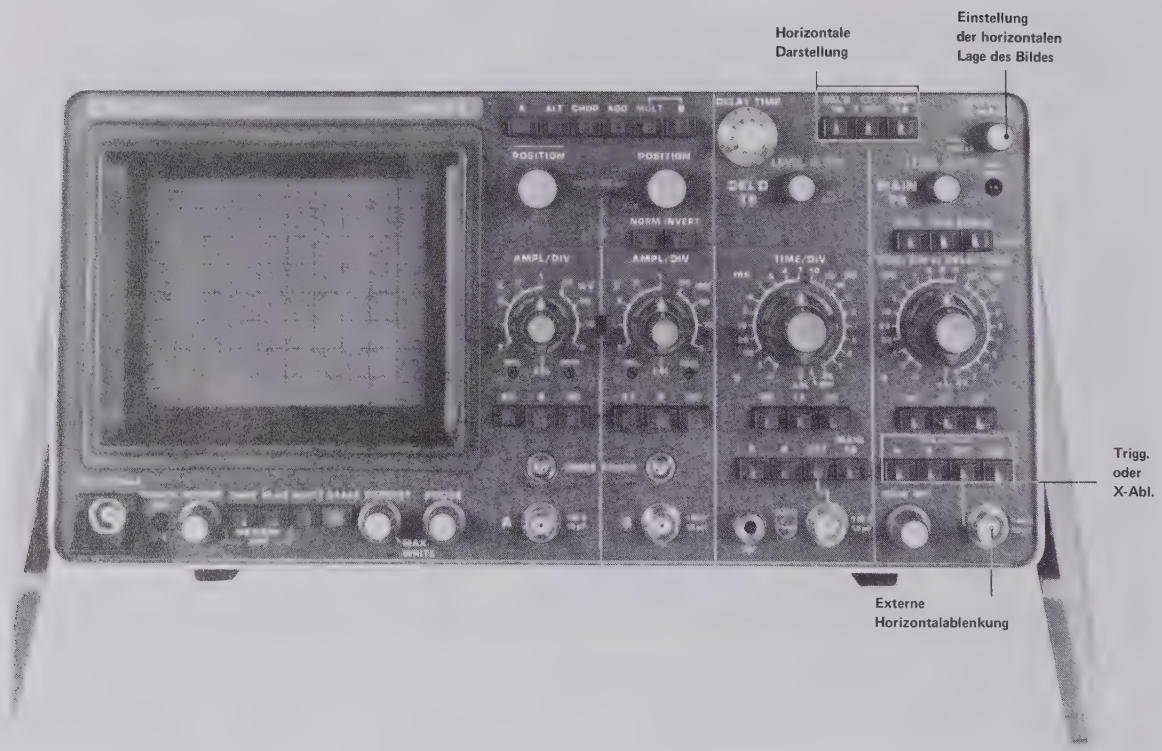


Fig. 2.4. Horizontalablenkung

Horizontale Darstellungsschalter	Einstellung der Horizontalablenkung; Drucktastenschalter mit 4 Stellungen.
MAIN TB eingedrückt	Horizontalablenkspannung wird vom Hauptzeitablenkgenerator geliefert; ein Teil der Darstellung wird aufgehellt (Ausgenommen in Stellung OFF des TIME/DIV Schalters des verzögerten Zeitbalenkgenerators). Ist keine Taste eingedrückt so gilt Einstellung MAIN TB.
EXT. X DEFL eingedrückt	Horizontalablenkung durch das Signal von Kanal A, das Signal von Kanal B, ein externes Signal oder durch ein Netzfrequenzsignal.
DEL'D TB eingedrückt	Die Horizontalablenkspannung wird vom verzögerten Zeitablenkgenerator geliefert.
TRIG or EXT X DEFL	Mit dem Gerät in Zeitablenkbetrieb, kann die Hauptzeitablenkung getriggert werden durch: A — Signal intern abgenommen von Kanal A B — Signal intern abgenommen von Kanal B EXT — Signal an Triggereingang gelegt LINE — Netzspannung intern angeschlossen
POSITION TB MAGN	Stufenlose Einstellung der horizontalen Lage des Bildes; gekoppelt mit einem Zug-Druck-Schalter der den Horizontalablenkkoeffizienten 5 mal steigert. Wenn ein externes X-Ablenksignal angewandt wird ist die Dehnung unwirksam.

Hauptzeitablenkung

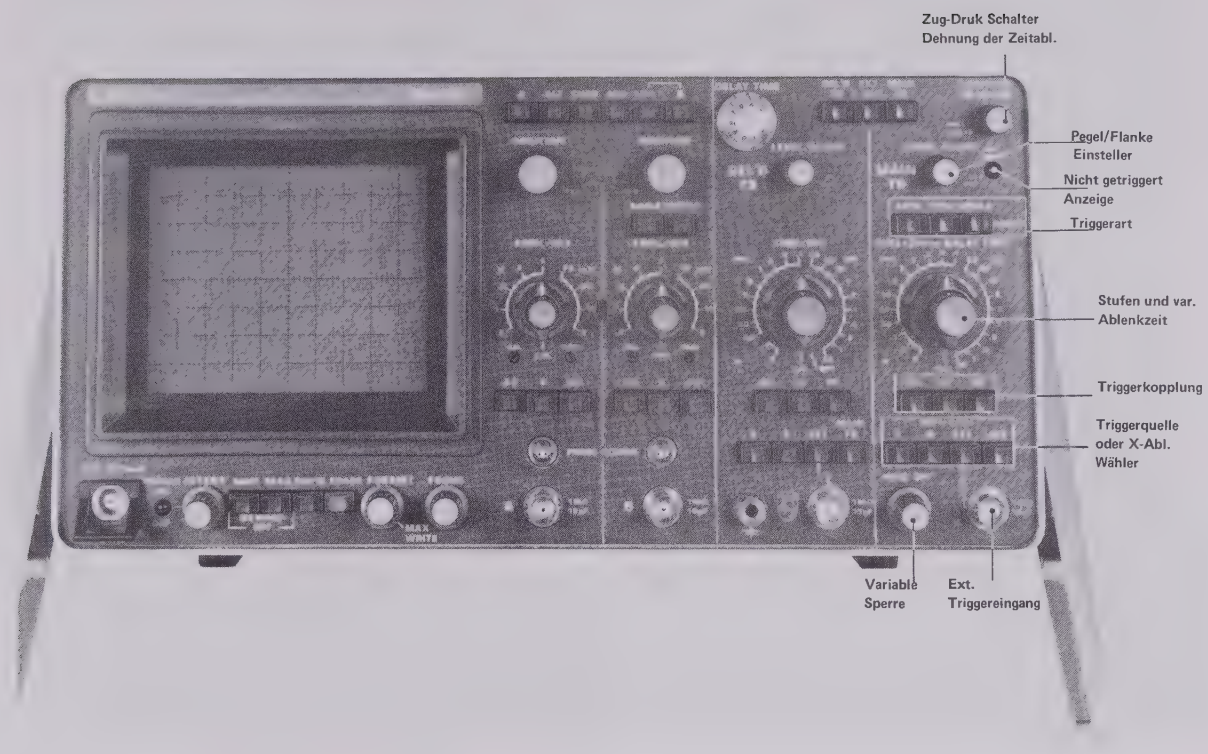


Fig. 2.5. Hauptzeitablenkung

LEVEL SLOPE	Stufenlose Einstellung des Triggersignalpegels bei welchem der Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt mit einem Zug-Druck-Schalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignales.
NOT TRIG'D	Signallampe leuchtet auf wenn die Zeitablenkung nicht getriggert ist, z.B. bei Wartestellung
AUTO - TRIG - SINGLE	Triggerart-Einstellungen; Drucktastenschalter mit 3 Stellungen.
AUTO eingedrückt	Liegt kein Triggersignal an so läuft der Hauptzeitablenker frei.
TRIG eingedrückt	Der Zeitablenkgenerator wird auf normale Weise getriggert.
SINGLE eingedrückt	Nach Betätigung der Taste SINGLE läuft der Zeitablenkgenerator nach Empfang eines Triggersignals nur einmal ab. Wenn keine Taste gedrückt ist gilt Betriebsart SINGLE. Wenn nach Einschaltung des Geräts und nach Anschluss des Eingangssignals kein Bild vorhanden ist, kontrollieren ob Betriebsart AUTO oder TRIG für die Hauptzeitablenkung eingestellt wurde.
TIME/DIV or DELAY TIME	Einstellung des Zeitkoeffizienten der Hauptzeitablenkung; Drehschalter mit 23 Stellungen.
TIME/DIV-CAL	Stufenlose Einstellung des Zeitkoeffizienten der Hauptzeitablenkung. In Stellung CAL ist der Zeitkoeffizient kalibriert.
DC/LF/HF	Triggerkopplung; Drucktastenschalter mit 3 Stellungen.
DC eingedrückt	Triggersignale direkt gekoppelt
LF eingedrückt	Kopplung über Tiefpassfilter für Frequenzen bis 50 kHz (für externe Triggerung über einen Bandfilter von 10 Hz bis 50 kHz).

HF eingedrückt	Kopplung über Hochpassfilter für Frequenzen über 50 kHz. Ist keine Taste eingedrückt so gilt Einstellung DC.
TRIG or X DEFL	Wähler für Triggerquelle oder externe X ablenkung. Drucktastenschalter mit 4 Stellungen.
A	Internes Trigger- oder X-Ablenksignal von Kanal A.
B	Internes Trigger- oder X-Ablenksignal von Kanal B.
EXT eingedrückt	Triggerung auf externes Signal über angrenzende 1 MOhm - 15 pF Buchse. Durch Eindrücken der Taste EXT X DEFL der Horizontalablenkungs-Einstellung wird diese Buchse mit dem Eingang des Horizontalverstärkers verbunden.
LINE eingedrückt	Triggerung- oder X-Ablenkungssignal von einer internen Spannung mit der Netzfrequenz. Ist keine Taste eingedrückt so gilt Einstellung A.
1 MOhm - 15 pF	BNC Buchse für externe Triggerung oder Horizontalablenkung.

Verzögerte Zeitablenkung

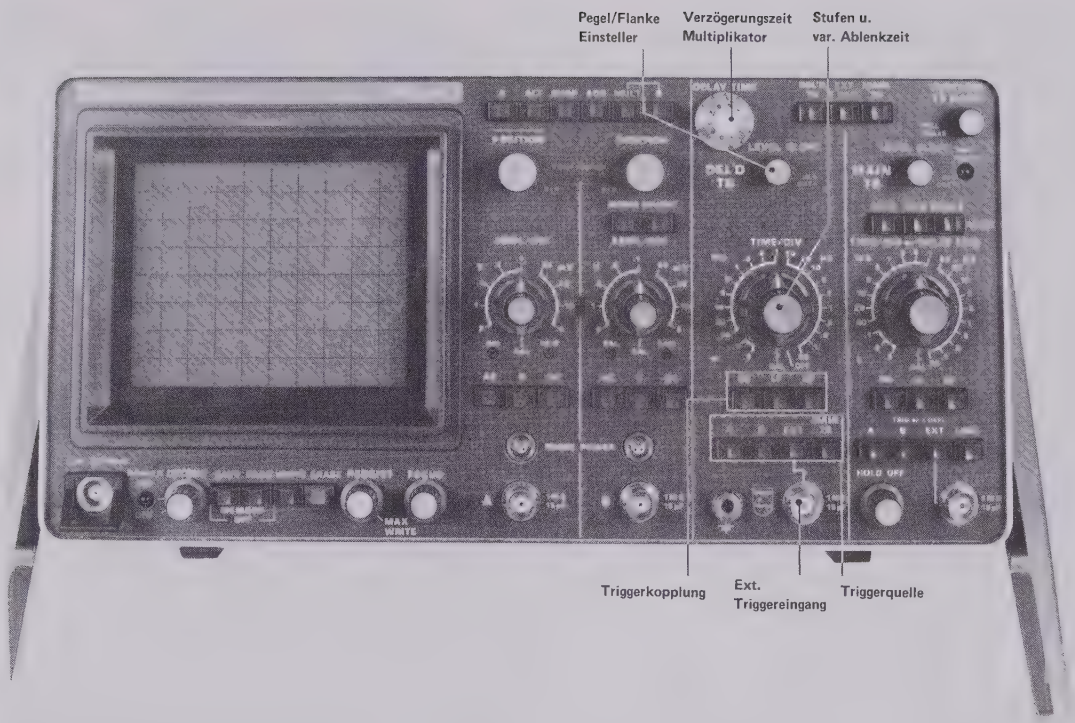


Fig. 2.6. Verzögerte Zeitablenkung

DELAY TIME	Kalibrierte stufenlose Einstellung der Verzögerungszeit, wirkt zusammen mit der TIME/DIV Einstellung des Hauptzeitablenkgenerators.
LEVEL SLOPE	Stufenlose Einstellung zur Pegelwahl des Triggerungsignals, bei welchem der verzögerte Zeitablenkgenerator startet. Diese Einstellung ist gekoppelt an einen Zug-Druck-Schalter zur Triggerungswahl auf der positiv oder negativ gerichteten Flanke des Triggersignals.
TIME/DIV	Einstellung des Zeitkoeffizienten der verzögerten Zeitablenkung Drehschalter mit 22 Stellungen. In Stellung OFF wird die verzögerte Zeitablenkung abgeschaltet.
TIME/DIV CAL	Stufenlose Einstellung des Zeitkoeffizienten der verzögerten Zeitablenkung. In Stellung CAL ist der Zeitkoeffizient kalibriert.
DC/LF/HF	Triggerkopplung; Drucktastenschalter mit 3 Stellungen.
DC eingedrückt	Triggersignale direkt gekoppelt
LF eingedrückt	Kopplung über Tiefpassfilter für Frequenzen bis 50 kHz (für externe Triggerung über einen Bandfilter von 10 Hz bis 50 kHz).
HF eingedrückt	Kopplung über Hochpassfilter für Frequenzen über 50 kHz. Ist keine Taste eingedrückt so gilt Einstellung DC.
A/B/EXT/MAIN TB	Triggerquelle Einstellungen; Drucktastenschalter mit 4 Stellungen.
A eingedrückt	Triggerbar, nach Verzögerungszeit, von Kanal A
B eingedrückt	Triggerbar, nach Verzögerungszeit, von Kanal B
EXT eingedrückt	Triggerbar, nach Verzögerungszeit, auf externes Signal über angrenzende 1 MOhm - 15 pF Buchse
MAIN TB eingedrückt	Verzögerte Zeitablenkung startet gleich nach Ablauf der Verzögerungszeit.
1 MOhm - 15 pF	BNC Eingangsbuchse für externes Triggersignal.

Elektronenstrahlröhre

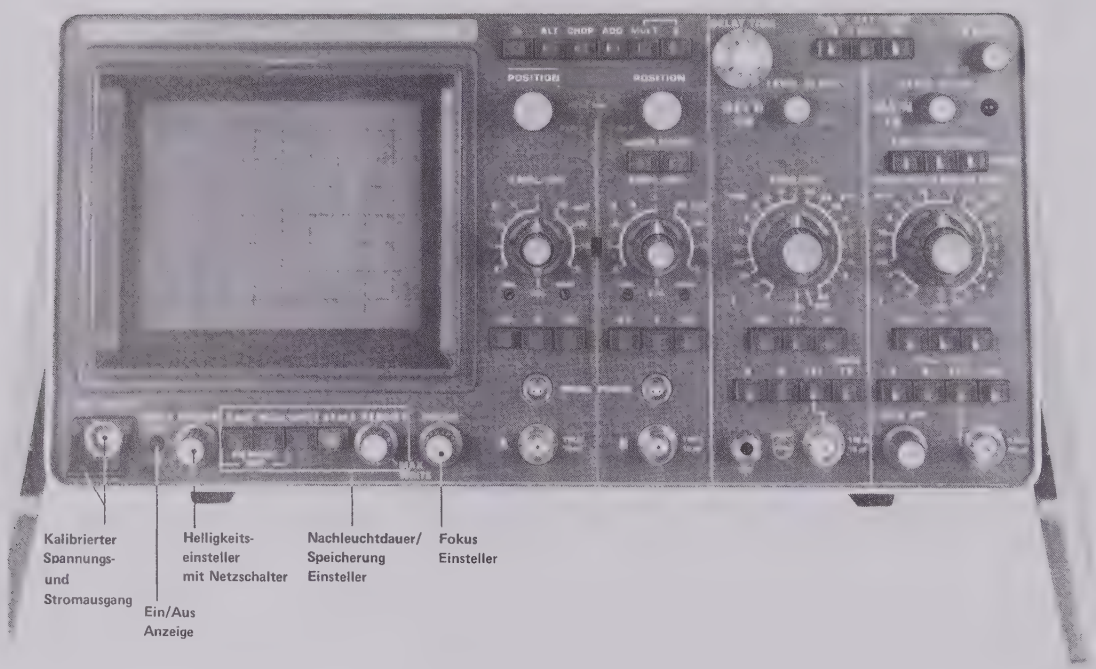


Fig. 2.7. Elektronenstrahlröhreteil

CAL	Ausgangsbuchse an der eine Rechteckspannung von 3 V_{ss} für Kalibrierung des Stellers AMPL und des Frequenzgangs von Spannungsteiler-Messköpfen zur Verfügung steht Stromschleife mit 6 mA_{ss} Strom für Kalibrierung von Strommessköpfen.
POWER ON/OFF	Signallampe zeigt Betriebszustand (ON) an.
INTENS	Stufenlose Einstellung der Helligkeit des Bildes, gekoppelt mit Schalter ON/OFF
FOCUS	Stufenlose Einstellung zur Fokussierung des Elektronenstrahls.

Speicherung/Nachleuchtdauer Einsteller

SAVE/READ/WRITE/ERASE	Signalformspeicherung; Drucktastenschalter, 4-fach.
SAVE	Ermöglicht Speicherung einer geschriebenen Signalform für längere Zeit. (Geschützt gegen versehentliche Löschung).
READ	Ermöglicht Beobachtung der geschriebenen Signalformen (geschützt gegen versehentliche Löschung).
MEMORY OFF (SAVE + READ)	Gestattet Betrieb des Geräts ohne Speicherung
WRITE	Ermöglicht Schreiben der Signalform; in dieser Betriebsart ist Einsteller PERSISTANCE wirksam
ERASE	Ermöglicht Löschung des Bildes in Betriebsart WRITE In Betriebsart SINGLE der Zeitablenkung wird mit diesem Schalter auch die Zeitablenkung rückgestellt.

Rückwand

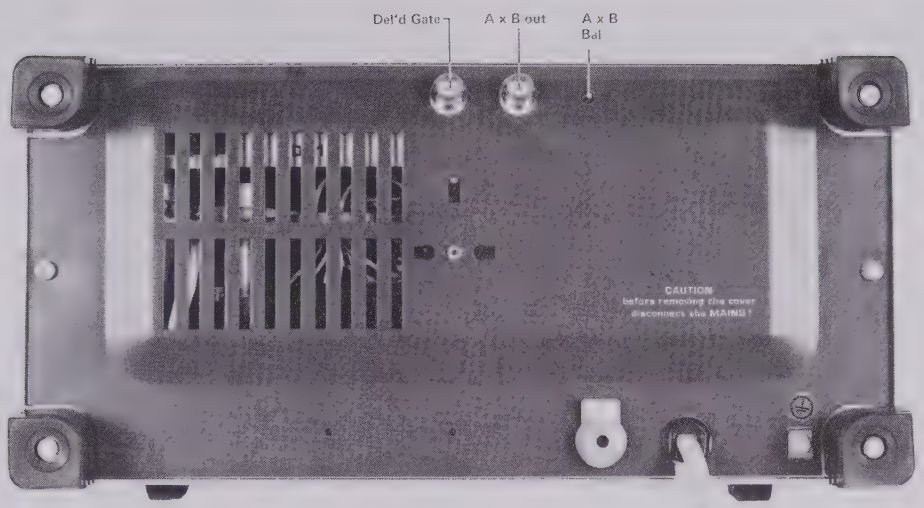


Fig. 2.8. Rückwand

DEL'D GATE	Torausgang der verzögerten Zeitablenkung; TTL kompatibel. Logik '1' während der aufgehellten Hauptzeitablenkung und der verzögerten Zeitablenkung Laufzeiten. Für Multiplikator Anwendung.
A x B OUT	Gleichspannungsgekoppelter nichtintegrierter Multiplikatorausgang.
A x B BAL	Ausgleich der Multiplikatorausgangssymmetrierung.
FUSE	Sicherung 2 A, träge. Für alle Netzspannungen.
Netzschnur mit Stecker Schutzerdeklemme.	

2.3. GRUNDEINSTELLUNGEN

Vor der Ausführung von Messungen mit diesem Gerät ist Prüfung und Einstellung folgender Funktionen erforderlich:

- Stufenverstärker Ausgleich
- Verstärkungs-Kalibrierung
- Symmetrierung des Multiplikators (0 x A, 0 x B)
- Symmetrierung des Multiplikatorausgangs.

Da die beiden ersten Einstellungen für beide Vertikalkanäle gleich sind, ist nur das Verfahren für Kanal A angegeben.

1. Stufenabschwächer-Ausgleich

- Drucktaste MAIN TB des Schalters der Horizontalablenkung eindrücken.
- Drucktaste AUTO des Schalters der Hauptzeitablenkung eindrücken
- Mit Einstellern INTENS und FOCUS die Bildschärfe regeln.
- Die entsprechende Kanaltaste des Schalters der Vertikalablenkung eindrücken.
- Taste 0 des Eingangskopplungsschalters eindrücken.
- Bild mit Einsteller POSITION zentrieren.
- Stufenlosen Einsteller AMPL auf CAL stellen.
- Es ist darauf zu achten, dass das Bild nicht springt wenn Stufenschalter AMPL gedreht wird.
- Nötigenfalls Einsteller BAL regeln.

2. Verstärkungskalibrierung

Falls nicht anders erwähnt, bleiben die Einstellorgane in den gleichen Stellungen wie im vorgehenden Verfahren.

- Schalter AC-0-DC auf AC stellen.
- Schalter AMPL auf .5 V und stufenlosen Einsteller auf CAL stellen.
- Eingang verbinden mit CAL-Ausgang.
- Kontrollieren ob die Vertikalablenkung genau 6 Teile beträgt. Nötigenfalls Einsteller GAIN regeln.
- Ein Abschwächermesskopf kann in diese Kalibrierung einbezogen werden.
- Der Abschwächungsfaktor des Messkopfs muss dann in Bezug auf die Stellung des Schalters AMPL berücksichtigt werden.

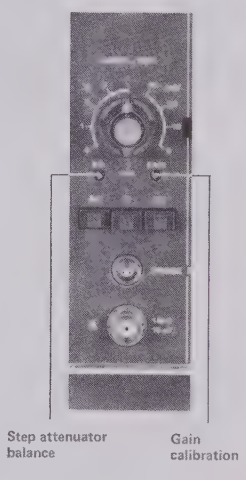


Fig. 2.9.

3. Symmetrierung des Multiplikators 0 x A, 0 x B

Wenn entweder A oder B mit Null multipliziert wird, muss das Ergebnis ebenfalls Null sein. Durch Verschiebespannungen an den Eingängen des Multiplikators kann jedoch auf dem Schirm eine gewisse Ablenkung auftreten. Diese Verschiebespannungen lassen sich wie folgt auf ein Minimum herabsetzen:

Bemerkung: Die Einsteller 0 x A und 0 x B werden durch Drücken der Tasten POSITION betätigt.

- Das Gerät mindestens 15 Minuten, besser noch 30 Minuten, vorwärmen lassen.
- An Eingang A und Eingang B eine Wechselspannung anschliessen, deren Amplitude im spezifizierten dynamischen Bereich liegt.
- Taste MULT der Darstellungsartschalter eindrücken.
- Taste 0 der Kanal A Signalkopplungs-Einsteller eindrücken.
- Taste AC der Kanal B Signalkopplungs-Einsteller eindrücken.
- Mit Potentiometer 0 x B minimale Ablenkung einstellen, ohne die Abschwächereinstellung zu ändern.
- Taste AC der Kanal A Signalkopplungs-Einsteller eindrücken.
- Taste 0 der Kanal B Signalkopplungs-Einsteller eindrücken.
- Mit Potentiometer 0 x A minimale Ablenkung einstellen, ohne dabei die Abschwächereinstellung zu ändern.

4. Symmetrierung des A x B Ausgangs

Bei Anwendung des A x B Ausgangs an der Rückwand, muss der Ausgang Null sein wenn beide Eingänge Null sind.
Dies lässt sich mit Steller A x B BAL, neben diesem Ausgang, ausgleichen.
Wie folgt vorgehen:

- Die 0 x A und 0 x B Einstellung kontrollieren, wie in Punkt 3 angegeben.
- Beide 0 Schalter der Kanal A und B Eingänge eindrücken.
- Einsteller A x B BAL regeln, ausser wenn die A x B Ausgangsspannung Null ist.

2.4. BEDIENUNGSANLEITUNGEN

Vor dem Einschalten überzeuge man sich dass der Oszillograf ordnungsgemäss anhand der "INBETRIEBNAHME" Vorschriften (Abschnitt 2.1.) installiert ist und dass die vorgeschriebenen Sicherheitsmassnahmen eingehalten wurden.
Soll das Gerät als normaler Oszillograf; das heisst ohne Speichereinrichtung verwendet werden, dann die Tasten SAVE und READ gleichzeitig eindrücken (MEMORY OFF).

Warnung: In Betriebsart EXT X DEFL darf keine zu hohe Helligkeit angewandt werden!

Eingänge A und B und ihre Möglichkeiten

Der Oszillograf besitzt zwei identische Kanäle, die entweder zusammen mit einem oder beiden Zeitablenkgeneratoren für YT Messungen, oder aber zusammen mit dem externen Horizontalkanal für XY Messungen verwendet werden können.

YT-Messungen

Zur Darstellung eines Signals ist einer der beiden Vertikalkanäle mit Taste A oder Taste B der Darstellungsartenschalter zu wählen.
Wird Taste ALT oder CHOP gedrückt, können zwei verschiedene Signale gleichzeitig abgebildet werden. Der Y-Ablenkkoeffizient kann für jeden Kanal getrennt gewählt werden. Wird Taste ALT betätigt dann wird die Darstellung beim Rücklauf des Zeitablenksignals von einem Kanal auf den anderen umgeschaltet. Obwohl Stellung ALT für alle Ablenkzeiten verwendet werden kann, ergibt für lange Ablenkzeiten Stellung CHOPPED eine bessere Bildgüte, da das abwechselnde Darstellen der beiden Eingangssignale während dieser langen Ablenkzeiten deutlicher sichtbar ist.

In Stellung CHOPPED, wird die Darstellung mit einer Festfrequenz von einem Kanal auf den anderen umgeschaltet.
In Stellung ADDED des Darstellungsartenschalters werden die Signalspannungen der beiden vertikalen Kanäle addiert. Abhängig von der Stellung der Polaritätsschalter von Kanal B wird entweder die Summe oder die Differenz der Eingangssignale dargestellt.

XY-Messungen

Wenn Drucktaste EXT X DEFL des Horizontalablenkungsschalters und Taste A des TRIG or X DEFL-Schalters eingedrückt sind ist der Zeitablenkgenerator ausgeschaltet. Ein Signal das über Kanal A zugeführt wird kann nur zur Horizontalablenkung verwendet werden, wenn Taste A des TRIG or X DEFL Schalters betätigt wird. Schalter AC-0-DC und der Stufenabschwächer von Kanal A bleiben wirksam.
Mit Hilfe des stufenlosen Einstellers AMPL ist kontinuierliche Einstellung der Ablenkkoeffizienten möglich und mit Einsteller X POSITION horizontale Verschiebung des Bildes.
Vertikalkanal B kann ebenfalls für X-Ablenkung verwendet werden. In diesem Fall ist Taste B der TRIG or DEFL Einsteller gedrückt.
Es ist ferner möglich eine interne Spannung der Netzfrequenz, oder ein Signal angelegt an die EXT Buchse (Vorderseite rechts unten), für die X-Ablenkung zu verwenden. Zu diesem Zweck die betreffende Drucktaste des TRIG or X DEFL-Schalters eindrücken.

AC/0/DC Schalter

Die zu beobachtenden Signale sind an die Buchse (n) A und/oder B zu legen und der AC/0/DC Schalter ist abhängig von der Zusammensetzung der Signale auf AC oder DC zu stellen. Da der vertikale Verstärker gleichspannungsgekoppelt ist, ist die ganze Bandbreite des Gerätes verfügbar und die Gleichspannungskomponenten werden in Stellung DC des AC/0/DC-Schalters als Bildverschiebungen sichtbar.
Sind kleine Signale hohen Gleichspannungen überlagert kann dies störend sein. Jede Abschwächung des Signals verursacht auch eine Abschwächung der kleinen Wechselspannungskomponenten. In diesem Falle ist der Eingangschalter in AC Stellung zu bringen wodurch ein Sperrkondensator die Gleichspannungskomponente unterdrückt. Dies hat Dachschräge zur Folge bei Darstellungen von Niederfrequenzsignalen.
Stellung 0 unterbricht das Signal und erdet den Verstärkereingang um den 0 V Pegel schnell bestimmen zu können.

Verwendung des Multiplikators

Die zu multiplizierenden Signale müssen an die Eingangsbuchsen A und B gelegt werden.

Dynamischer Bereich

Beide Faktoren A und B müssen im dynamischen Bereich des Multiplikators und der Vorverstärker liegen.
Da eine Übersteuerung dieser Schaltungen nicht ohne weiteres im Produkt zu erkennen ist, ist sehr darauf zu achten, dass jedes Eingangssignal innerhalb des spezifizierten dynamischen Bereichs liegt, d.h., dass die Amplitude maximal 8 $Teile_{s-s}$ beträgt.
Für das dargestellte Produkt gilt wiederum eine maximale Amplitude von 8 $Teilen_{s-s}$. Wenn das maximal zulässige Ausgangssignal überschritten wird, muss die Amplitude von einem der Eingangssignale herabgesetzt werden.

Ausgangspegel des Multiplikators

Das Ausgangssignal des Multiplikators wird über Kanal A dargestellt.
Das abgebildete Produkt enthält normalerweise eine Gleichspannungskomponente, auch wenn beide Eingangssignale Wechselspannungen sind.
Deshalb muss der Nullpegel des abgebildeten Produkts unbedingt bekannt sein.
Wenn einer der Schalter AC/0/DC auf 0 gestellt wird, kann die Gleichspannungs-Nullinie mit Einsteller POSITION von Kanal A in die günstigste Stellung am Bildschirm geschoben werden.

Verwendung der Nachleuchtdauer/Speicher Einrichtung

Ausgehend von Stellung MEMORY OFF (Drucktasten SAVE und READ gleichzeitig eingedrückt) und einem mit INTENS und FOCUS scharf eingestelltem Bild, wird durch Eindrücken der Taste WRITE Betriebsart PERSISTANCE/STORAGE erhalten.
Die Funktionen der übrigen Einstellorgane sind dann die folgenden:

PERSIST	Abhängig von der Stellung des Potentiometers PERSIST erscheint eine rasch verschwindende Schreibspur auf grünen Hintergrund (Knopf ganz auf Linksanschlag gedreht) oder eine sehr langsam verschwindende Schreibspur auf schwarzem Hintergrund (Knopf auf ersten Stop rechtsherum). Beim Darstellen eines NF-Signals kann die Nachleuchtdauer so eingestellt werden, dass jedes Flimmern der Anzeige unterdrückt wird. Bei einem Signal mit niedriger Folgefrequenz und kurzer Anstiegzeit kann die Nachleuchtdauer so eingestellt werden dass das Bild aufgefüllt wird und eine deutliche und stabile Darstellung erhalten wird.
SAVE	Soll eine bestimmte Darstellung festgehalten werden, lässt sie sich durch Eindrücken der Taste SAVE bewahren. Das Bild ist dann gerade noch sichtbar.
READ	Die Helligkeit der gespeicherten Strahlspur wird nach Eindrücken der Taste READ grösser, die Helligkeit wird jedoch auf Kosten der Speicherzeit erzielt.
ERASE	Wird die Strahlspur nicht mehr benötigt, dann kann sie durch Eindrücken der Taste ERASE, gelöscht werden. Es kann vorkommen, dass die Strahlspur nicht gänzlich verschwindet besonders die mit beträchtlicher Helligkeit geschriebenen Teile. Dies lässt sich durch langzeitige Betätigung der Taste "ERASE" überwinden.
MAX. WRITE	Die Schreibgeschwindigkeit lässt sich um etwa einen Faktor 10 erhöhen. Dies geschieht durch Einsteller PERSIST bis auf den zweiten rechtsläufigen Anschlag (MAX. WRITE) zu drehen, so dass der zugehörige Schalter wirksam wird. Betriebsart MAX. WRITE ist für kurze Ablenkzeiten oder für Signal mit kurzer Anstiegzeit erforderlich.

Triggerung

Wenn ein Signal dargestellt werden soll, muss, um ein stillstehendes Bild zu erhalten, die Horizontalablenkung stets an einem festen Punkt des Signals gestarted werden.
Der Zeitablenkgenerator wird folglich von in der Triggereinheit erzeugten schmalen Triggerimpulsen gestartet

und durch ein Signal gesteuert das entweder den vertikalen Eingangssignalen, einer internen Netzfrequenzspannung oder einer externen Quelle entstammen kann.

Triggerkopplung

Mit Schalter DC/LF/HF kann man drei verschiedene Triggerkopplungsarten wählen. In den Stellungen HF und LF ist die Übertragungscharakteristik begrenzt.
In Stellung DC wird das Triggersignal unverändert durchgelassen.
In Stellung LF wird ein 0 Hz (10 Hz bei externer Triggerung) bis 50 kHz Bandpass eingesetzt. Diese Stellung dient zur Verminderung von Störungen durch Rauschen.
In Stellung HF wird ein 50 kHz Hochpass eingesetzt. Diese Stellung kann zum Herabsetzen von Störungen durch Brummen verwendet werden.

Wahl der Triggerquelle und Einstellen des Triggerpegels

Das Triggersignal kann von Kanal A (Taste A gedrückt), von Kanal B (Taste B gedrückt), von einer externen Quelle (Taste EXT gedrückt) oder einer internen Spannung mit Netzspannung (Taste LINE gedrückt) entnommen werden.
Der Triggerimpulsformer ist ein Multivibrator, der von den Ausgangssignalen eines Differenzverstärkers gesteuert wird.
Das Triggersignal, wird zusammen mit Gleichspannungen die mittels Potentiometer LEVEL einstellbar sind, den Eingängen des Differenzverstärkers zugeführt.
Abhängig von der LEVEL Einstellung wird ein Bestimmter Teil des Triggersignals durch den Differenzverstärker verstärkt.
Der Multivibrator ist somit auf einen festen Punkt des Triggerssignals geschaltet. Das bedeutet, dass es mit Hilfe des Einstellers LEVEL möglich ist die Form des Triggersignals abzutasten (bei interner Triggerung A oder B gleich der Form des darzustellenden Signals) und somit den Punkt zu wählen, an dem der Multivibrator umgeschaltet wird.
Der Potentiometer LEVEL ist mit einem Zug-Druck-Schalter versehen, der die Wahl der Triggerflanke erlaubt.

Automatische Triggerung

Wenn Taste AUTO des AUTO-TRIG-SINGLE-Schalters gedrückt ist - und wenn keine Triggerimpulse vorhanden sind - ist der Zeitablenkgenerator automatisch freilaufend. Das Bild ist daher stets sichtbar. Die Stellung AUTO kann in allen Fällen verwendet werden in welchen auch Stellung TRIG anwendbar ist, ausgenommen bei Signalfrequenzen niedriger als 10 Hz oder Impulsreihen mit einer "AUS"-Zeit über 100 ms.
Sobald Triggerimpulse vorhanden sind, wird der Freilauf des Zeitablenkgenerators automatisch beendet und der Zeitablenkgenerator erneut getriggert.
Wird Taste TRIG oder Taste SINGLE eingedrückt ist die Automatik ausgeschaltet.
Die Einstellung LEVEL kann auch in Betriebsart AUTO angewandt werden.

SINGLE sweep Triggerung

Wenn einmalige Vorgänge beobachtet (und in der Regel fotografiert) werden müssen, ist es oft wünschenswert dafür zu sorgen, dass nur ein Sägezahn erzeugt wird, selbst wenn möglicherweise nach Darstellung dieses Vorgangs mehrere Triggerimpulse erzeugt würden. Zu diesem Zweck Taste SINGLE eindrücken. Der erste Triggerimpuls, der nach Loslassen der gedrückten Taste erscheint, startet den Zeitablenkgenerator.
Der Zeitablenkgenerator wird dann blockiert bis Taste SINGLE wieder betätigt wird. Die Lampe NOT TRIG'D leuchtet auf sobald Taste SINGLE losgelassen wird und erlischt erst wenn der Sägezahn beendet ist.
Es ist zu beachten dass mit Taste ERASE die Zeitablenkung auf Betriebsart SINGLE rückgestellt wird.

Dehnung der Zeitablenkung MAGN

Die Dehnung der Zeitablenkung wird mit einem Zug-Druck-Schalter TB MAGN der an den Einsteller für horizontale POSITION gekoppelt ist, eingestellt. Wenn dieser Schalter in Stellung x5 gezogen ist wird ein 5 mal schnellerer Zeitmassstab des Hauptzeitablenkgenerators eingestellt. Folglich wird der Signalteil, welcher in der x1 Stellung (TB MAGN eingedrückt) über eine Breite von zwei Teilen in der Schirmmitte dargestellt wird, in der x5 Stellung über die Gesamtbreite des Schirmes geschrieben.
Jeder Teil des Bildes kann mit dem horizontalen POSITION Einsteller zur genauen Beobachtung sichtbar gemacht werden.
In der x5 Stellung wird der Zeitkoeffizient durch Teilen des gegebenen Wertes TIME/DIV. durch 5 ermittelt.

Gebrauch der verzögerten Zeitablenkung

Wenn die Drucktaste MAIN TB des Schalters der horizontalen Darstellung eingedrückt wird und wenn der Knopf TIME DIV der verzögerten Zeitablenkung nicht in Stellung OFF steht, wird ein Teil der Hauptzeitablenkung zusätzlich aufgehellt. Auf diese Weise lässt sich ein Teil des dargestellten Signals für nähere Betrachtung auswählen. Durch Eindrücken der Taste DEL'D TB wird der gewählte Teil über die gesamte Schirmbreite sichtbar gemacht.
Die Ablenkzeit des zusätzlich aufgehellten Teils des Hauptzeitablenksignals wird von der Einstellung des Knopfs TIME/DIV bestimmt.
Mit dem inneren Knopf lassen sich Ablenkzeiten zwischen den Stufen einstellen. Für Zeitmessungen muss dieser Knopf immer auf CAL stehen.
Der Startpunkt der verzögerten Zeitablenkung wird von den Einstellungen des Schalters TIME DIV der Hauptzeitablenkung oder des 10-Gangs-Multiplikatorknopfs DELAY TIME bestimmt.
Wenn der Triggerwahlschalter MAIN TB der verzögerten Zeitablenkung eingedrückt wird dann ist die Verzögerungszeit, nach welcher die verzögerte Zeitablenkung startet, das Produkt der Einstellungen des Schalters TIME/DIV der Hauptzeitablenkung und des Multiplikatorknopfs DELAY TIME.

Falls anstelle von MAIN TB die verzögerte Zeitablenkung von A, B oder EXT getriggert wird, dann startet der erste Triggerimpuls nach der Verzögerungszeit die verzögerte Zeitablenkung. Die Triggereinheit des verzögerten Zeitablenkgenerators liefert diesen Triggerimpuls. Diese Stellung kommt zur Anwendung wenn Zeitjitter ein undeutliches Bild der zu beobachtenden Einzelheit verursacht. Dieses Jitter kann durch das zu beobachtende Signal selbst oder bei übermässiger Dehnung in den Zeitablenkschaltungen entstehen.

Notice d'emploi

1. Généralités

1.1. INTRODUCTION

L'oscilloscope mémoire multiplicateur 50 MHz portatif PM 3243 permet de mesurer, mémoriser et multiplier des signaux à haute sensibilité (5 mV/DIV).

Un grand choix de modes d'affichage est possible: voie simple, deux voies alternées ou découpées, deux voies additionnées, en position normale et inversée pour un signal d'entrée, deux voies multipliées et base de temps principale et retardée.

L'oscilloscope PM 3243 se caractérise par une alimentation à faible dissipation. L'unité d'alimentation fonctionne pour toute tension alternative comprise entre 90 V et 264 V ou toute tension continue comprise entre 100 et 200 V, de sorte qu'il n'est pas nécessaire d'adapter l'appareil à la tension secteur locale.

Toutes ces caractéristiques font du PM 3243 un appareil aux nombreuses possibilités d'application.

En résumé l'oscilloscope PM 3243 présente les caractéristiques importantes suivantes:
- sensibilité de 5 mV à 50 MHz.
- multiplicateur 40 MHz incorporé
- affichage simultané du produit et d'un des facteurs
- persistance variable et mémoire
- technique d'avant-garde
- alimentation extrêmement efficace pour une grande gamme d'alimentations (alternative ou continue) sans commutation de la tension.

Note: Cet appareil est l'objet de développements et améliorations continuels. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.

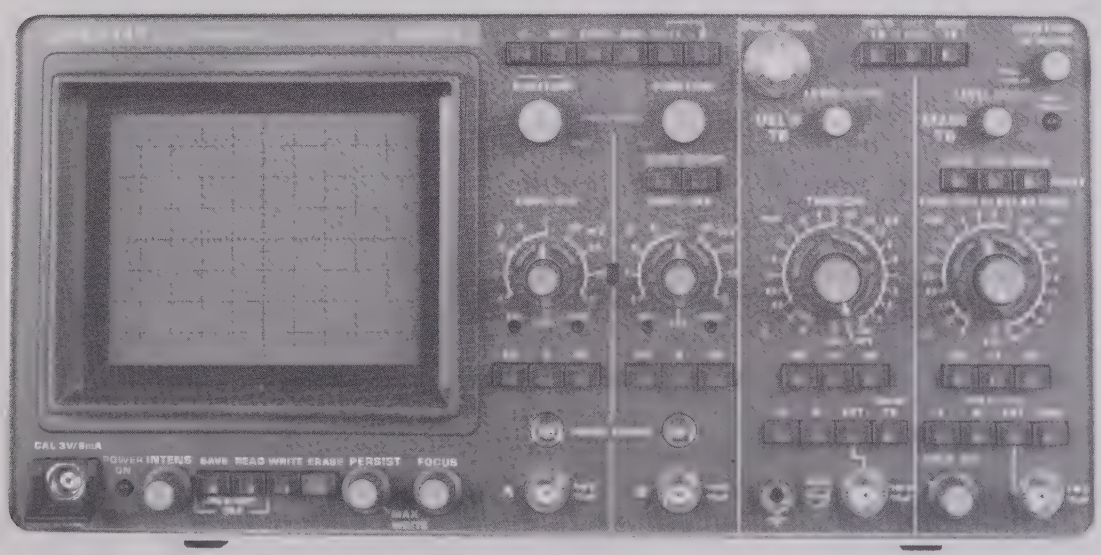


Fig. 1.1. PM 3243

1.2. CARACTERISTIQUES TECHNIQUES

Cet appareil a été conçu et testé conformément à la norme C.E.I. 348 pour appareils de classe I. A sa livraison il répond aux règles de sécurité. La présente notice comporte les informations et les avertissements nècessaires à l'utilisateur afin d'assurer le fonctionnement de l'appareil dans les conditions de sécurité et de le maintenir conforme à la norme.

Les spécifications sont valables après que l'appareil a été préchauffé pendant 30 minutes.
Les valuers exprimées numériquement avec tolérance sont garanties par le fabricant. Les valeurs sans tolérance ne servent qu'à titre d'information et correspondent aux caractéristique d'un appareil moyen.

Désignation	*Spécification*	*Information supplémentaire*
Tube à rayons cathodiques		
Type	89L14GH/55	Tube-mémoire rectangulaire demi-teinte à post-accélérateur.
Aire de mesure	8 x 10 div.	1 division = 0,9 cm
Type d'écran	Phosphore P31	
Tension d'accélération totale	8,5 kV	
Graticule	Interne	
Persistance		
Normale	Persistance naturelle du phosphore P31	(10 μs . . . 1 ms)
Variable	Continuellement variable de 0,3 sec à 1,5 min.	
Temps de mémoire		
En mode "WRITE" (persist. max.)	1,5 min	
En mode "READ"	3 min	
En mode "SAVE"	15 min	
Vitesse d'écriture		
Normal	0,2 div/μs	
Ecriture maximale	2 div/μs	
Effaçage	Un bouton-poussoir permet l'effaçage en 800 ms environ	
Axe vertikal ou Y		
Nombre de voies	2	
Modes d'affichage	Voie A uniquement Voie B uniquement A et B découpées A et B alternées A et B additionnées A x B multipliées A x B et B, découpées La polarité de la voie B peut être inversée	
Fréquence de découpage	1 MHz	
Temps d'affichage par voie	environ 500 ns	
Largeur de bande	continu . . . 50 MHz	couplage direct limite supérieure –3 dB
	10 Hz . . . 50 MHz	couplage capacitif limite –3 dB
Temps de montée	7 ns	

Designation	*Spécification*	*Information supplémentaire*
Coefficients de déviation	5 mV/div . . . 2 V/div	9 positions étalonnées en progression 1-2-5. Avec commande non-calibrée entre les échelons 1:2,5
Précision	± 3 %	
Dépassement	2 % max	
Tension d'entrée maximale admise	± 400 V	Tension continue + tension alternative crête
Impédance d'entrée	1 MOhm//15 pF	
Couplage d'entrée	AC-0-DC	
Temps RC d'entrée	22 ms	Couplage capacitif
Balance d'atténuateur	0,2 div max.	Mouvement de trace en commutant entre les positions d'atténuateur ou en commande continue
Instabilité de la position de spot	0,05 div/heure max 0,01 div/°C max.	 +10 °C . . . +40 °C
Gamme dynamique	24 divisions 6 divisions max.	15 MHz tension sinusoïdale 50 MHz tension sinusoïdale
Gamme de décalage	16 divisions	
Diaphonie entre les voies A et B seulement	40 dB	Découpé ou alterné (cont. . . . 50 MHz)
Amplitude totale maximale du signal d'entrée en A moins B	24 x réglage d'atténuateur	
Multiplicateur		
Largeur de bande	Continu - 40 MHz	−3 dB A mesurer avec un signal sinusoïdal sur une voie et un signal continu sur l'autre
Modes d'affichage	A x B A x B et B	+ ou −B + ou −B, découpée
Temps de montée	9 ns	
Facteur d'échelle	1 ± 2 %	Par rapport aux hauteurs d'affichage de tout facteur ou produit
Gamme dynamique		
Signal A ou B	8 div	(± 4 div. à partir du centre)
Signal A x B	8 div	(± 4 div. à partir du centre)
Non-linéarité	± 4 % max. de pleine déviation d'échelle	
Fuite	0,2 div. max.	−3 dB
Produit off-set	0,2 div. max.	
Dérive du produit off-set	0,03 div/°C max.	
Délai de propagation	8 ns max.	
Sortie	BNC à l'arrière	Couplage continu
Coefficient d'échelle	100 mV/div ± 4 % 50 mV/div ± 5 %	10 kohm charge 50 ohm charge, dans la gamme dynamique
Aberrations d'impulsion	5 %	

Designation	*Spécification*	*Information supplémentaire*
Offset de sortie	10 mV max.	10 kohm charge, réglage de l'extérieur
Dérive de sortie	3 mV/°C	10 kohm charge

Axe horizontal ou X

La déviation horizontale peut être obtenue soit à partir de la base de temps principale, soit à partir de la base de temps retardée ou d'une combinaison des deux, ou encore à partir d'une source pour déviation X. Dans le dernier cas, les diagrammes X-Y peuvent être affichés en utilisant la voie A ou B, le connecteur EXT ou le réseau comme source de déviation horizontale.

Modes d'affichage	Base de temps principale Base de temps principale intensifiée par base de temps retardée Base de temps retardée Fonctionnement XY	 Par Y_A, Y_B, EXT ou réseau

Amplificateur horizontal

Largeur de bande	Continu à 1 MHz sur 6 divisions, limite supérieure –3 dB
Coefficient de déviation	450 mV/div à l'aide du connecteur EXT. Les coefficients de déviation de l'atténuateur vertical s'appliquent lorsque Y_A ou Y_B est utilisé à la déviation X.
Impédance d'entrée	1 MOhm//15 pF
Précision de mesure	± 10 % par l'entrée Y_A ou Y_B
Erreur de phase	3° à 100 kHz

Base de temps principale

Modes	Automatique, déclenché, balayage unique 0,5 s/div . . . 50 ns/div en progression 1-2-5 Commande continue non-calibrée entre échelons 1:2,5 L'agrandisseur x5 permet d'accroître le taux de balayage maximal à 10 ns/div.
Blocage variable	Le temps de blocage du balayage peut être accrû d'un facteur 5 au moins.
Précision	± 3 % Exception: 0,5 sec et 0,2 sec ± 5 % 100 et 500 nsec ± 5 % Précision de balayage sur 2 divisions arbitraires de balayage 10 div est ± 5 %. Exclut les première et dernière divisions aux taux de balayage agrandis de 10 ns/div et 20 ns/div.

Base de temps retardée

La base de temps retardée démarre immédiatement après le retard ou peut être déclenché après le retard par une source de déclenchement de base de temps.

Coefficients de temps	0,2 s/div . . . 50 ns/div en progression 1-2-5 Commande continue non-calibrée entre échelons 1:2,5 L'agrandisseur x5 permet d'accroître le taux de balayage maximal à 10 ns/div.
Précision	± 3 % Exception: 0,2 sec ± 5 % 100 et 50 nsec ± 5 %. Précision de balayage sur 2 divisions arbitraires de balayage 10 divisions est ± 5 %. Exclut les première et dernière divisons aux taux de balayage agrandis de 10 ns/div et 20 ns/div.

Designation	*Spécification*	*Information supplémentaire*
Délai de balayage	En échelons, variable avec la base de temps principale. Continûment variable par potentiomètre 10 tours entre 0,2x et 10x le coefficient de temps de la base de temps principale	
Jitter du temps de retard	1:20.000	
Erreur de temps de retard supplémentaire	0,5 %	
Sortie de porte retardée	Connecteur arrière produisant une impulsion de sortie logique '1' TTL en cours de fonctionnement de la base de temps principale intensifiée et de la base de temps retardée. Pour applications du multiplicateur.	
Déclenchement de base de temps principale		
Source de déclenchement	Interne voie A ou B Externe Réseau (secteur)	
Pente	+ ou −	
Couplage de déclenchement (voir Fig. 1.2.)	Continu (continu à 50 MHz) Basse fréquence (continu à 50 kHz interne - 10 Hz à 30 kHz externe) Haute fréquence (50 kHz . . . 50 MHz) Libre automatique (temps de réaction ⩽ 100 nsec)	
Sensibilité	Interne < 0,5 div (1/3 div. typique) Externe < 150 mV (100 mV typique)	
Gamme de niveau	Interne 24 div typique Externe −5 à +5 V typique	
Impédance d'entrée externe	1 MOhm//15 pF	Identique à l'entrée Y
Déclenchement de base de temps retardée		
Source de déclenchement	Interne, voie A ou B Externe D'autres spécifications de déclenchement de la base de temps retardée sont identique à celles de la base de temps principale.	
Etalonneur d'amplitude		
Tension	+3 V	Rectangulaire, ligne de base 0 V
Courant	6 mA	Rectangulaire, par boucle de courant
Précision	± 1 %	Pour tension et courant
Fréquence	2 kHz ± 2 %	
Protection	La sortie est exempte de courts-circuits	
Alimentation		
Tensions réseau	Accepte toute tension entre 100 V et 240 V ± 10 % à toute fréquence entre 46 et 440 Hz dans une gamme sans commutation.	
Alimentation continue	Accepte toute tension continue entre 100 V et 200 V	
Consommation	39 W	
Alimentation de sonde	Deux douilles engendrant +24 et −24 V pour sondes actives. Courant maxi 2x50 mA pour chaque sortie	

Possibilités d'application en rapport avec l'environnement

Les données d'environnement ne s'appliquent que lorsque l'appareil est contrôlé conformément aux processus officiels. Pour plus de détails sur ces processus et les critères de panne, s'adresser à l'organisation Philips locale ou à N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Température ambiante	+5 °C . . . +40 °C	Gamme nominale d'utilisation
	−10 °C . . . +55 °C	Gamme limite de fonctionnement
	−40 °C . . . +70 °C	Gamme d'emmagasinage et de transport
Altitude	5000 m	Fonctionnement
	15000 m	A l'arrêt
Humidité	L'appareil répond aux normes IEC 68 Db	
Choc	1000 chocs de 10 g, ½ sinusoïde, durée 6 ms, dans chacune des directions	
Vibration	30 min. dans chacune des trois directions, 10 . . . 150 Hz, 0,7 mm crête-à-crête et 5 g accélération maximale.	
Temps de rétablissement	30 minutes (en fonctionnement normal)	Quand l'appareil passe de −10 °C à +20 °C à 60 % d'humidité relative
Perturbation electromagnétique	L'appareil répond aux normes VDE, Störgrad K	

Caractéristiques mécaniques

Dimensions	Hauteur	154 mm
	Largeur	316 mm
	Profondeur	460 mm
Poids	10,6 kg	

Options

Les options suivantes sont disponibles.
Pour plus de détails, consulter le technicien de service Philips local.
– Sortie de balayage de base de temps principale
– Sortie de porte de base de temps principale
– Sortie de balayage de base de temps retardée.

Accessoires

– Livrés avec l'appareil

Deux sondes passives 1:10
Filtre de contraste
Couvercle frontale avec remplacements pour accessoires
Visière pliante PM 9366
Adaptateur BNC banane PM 9051
Borne CAL - Adaptateur BNC
Notice d'emploi et d'entretien

Certains accessoires mentionnés ci-avant se trouvent à l'intérieur du couvercle.

– En option

PM 9335	Sonde passive 1:1 (1,5 m)
PM 9335L	Sonde passive 1:1 (2,5 m)
PM 9350	Sonde passive 10:1 (1,5 m) 50 MHz
PM 9350L	Sonde passive 10:1 (2,5 m) 50 MHz
PM 9358	Sonde HT 100:1 150 MHz
PM 9347	Sonde active de déclenchement TV
PM 9352	Sonde miniature
PM 9353	Sonde active à FET 150 MHz
PM 9355	Sonde de courant
PM 8910	Filtre Polaroïd
PM 9380	Caméra d'enregistrement

PM 8971	Adaptateur pour PM 9380
M3 . . . M5	Caméras d'enregistrement Steinheil
PM 8960	Adaptateurs pour montage en rack 19"
PM 8980	Visière longue
PM 8901	Batteries rechargeables 140 V continu 24 V continue
PM 8991	Table roulante
PM 8992	Malette pour accessoires

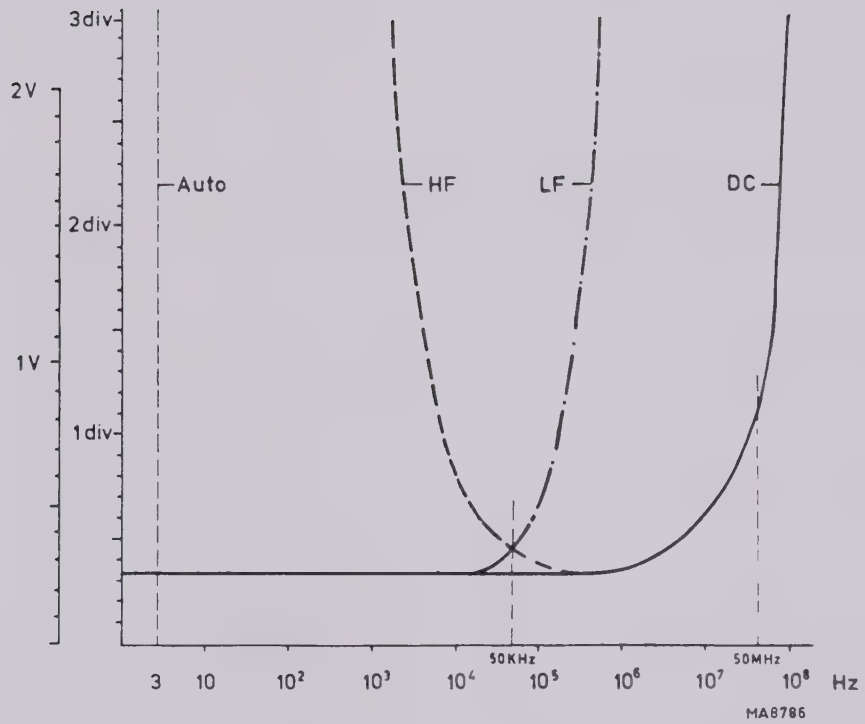


Fig. 1.2. Sensibilité pour déclenchement

1.3. GLOSSAIRE PARTICULIER A L'OSCILLOSCOPE MULTIPLICATEUR

1. Multiplicateur analogique

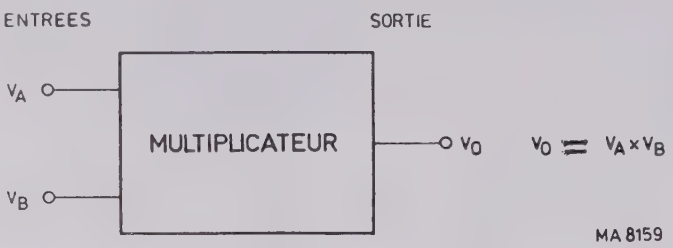


Fig. 1.3. Multiplicateur analogique

Un multiplicateur analogique est une unité non-linéaire qui produit une tension de sortie proportionnelle au produit algébrique de deux tensions d'entrée.

2. Largeur de bande de multiplicateur

La largeur de bande du multiplicateur est la gamme de fréquence entre DC et la limite de fréquence supérieure à laquelle la sortie du multiplicateur est 3 dB inférieure par rapport à la sortie à basse fréquence donnée. Cette largeur de bande est spécifiée par la sinusoïde à amplitude constante et fréquence variable appliquée à une entrée et la tension continue à l'autre.

3. Temps de montée du multiplicateur

Le temps de montée du multiplicateur est le temps de réponse d'impulsion de sortie lorsqu'une tension rectangulaire est appliquée à une entrée et une tension continue à l'autre.
Ce temps est mesuré entre les points 10 % et 90 % de la réponse.

4. Opération quatre quadrant

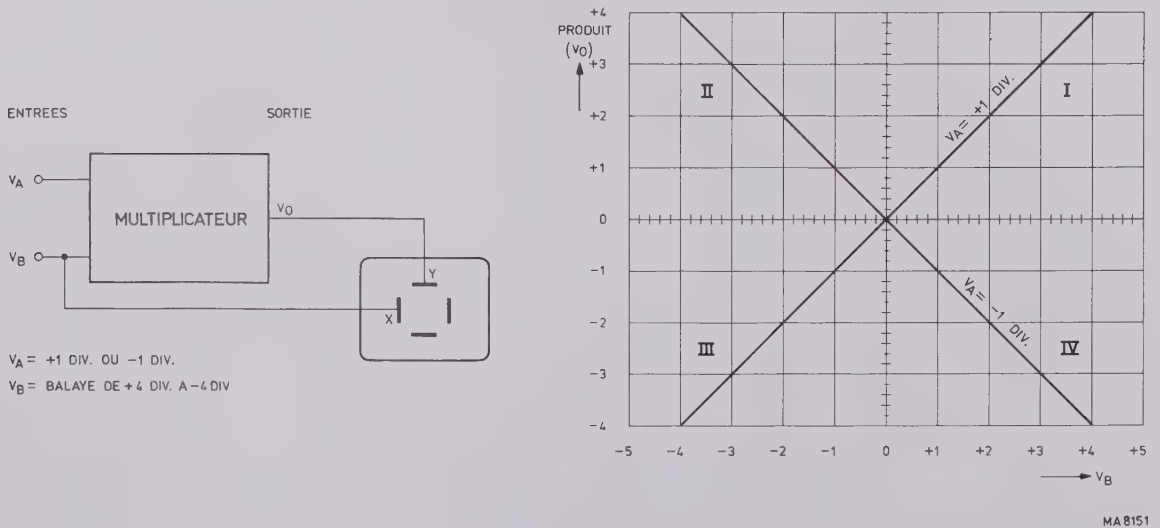


Fig. 1.4. Opération quatre quadrant

Un multiplicateur quatre quadrant peut produire un signal de sortie dans chacun des quatre quadrants (marqués I à IV) d'un système de coordonnées cartésien.

5. Tension offset d'entrée

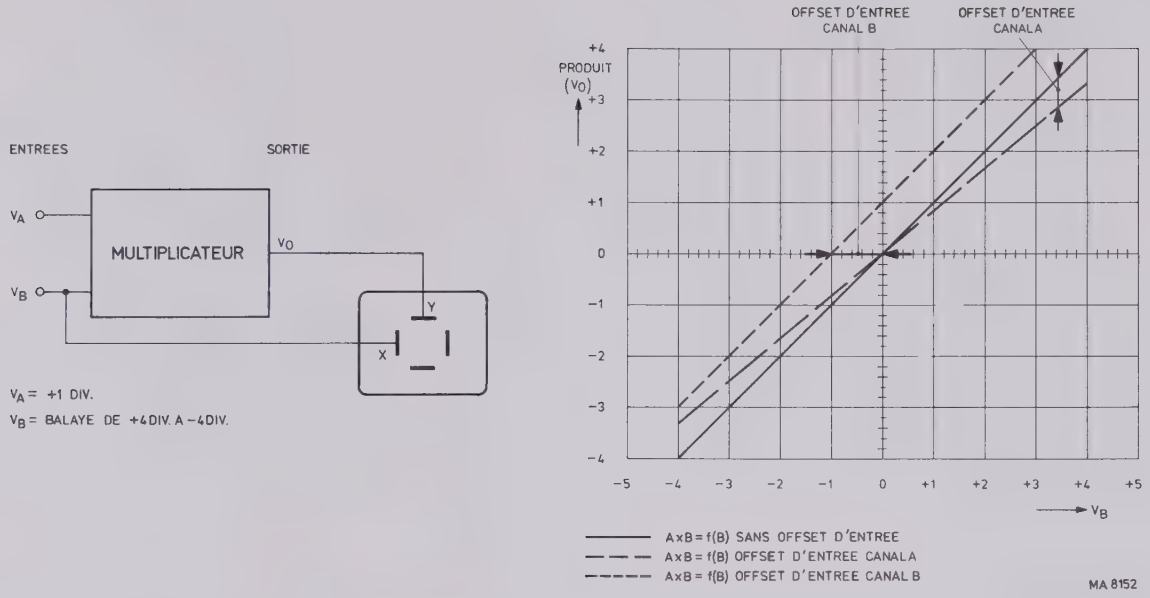


Fig. 1.5. Offset d'entrée

La tension offset d'entrée est une tension virtuelle à l'entrée du multiplicateur lorsqu'aucun signal d'entrée n'est appliqué. Cette tension peut être réduite en appliquant une tension d'équilibre continu.

6. Tension offset de sortie

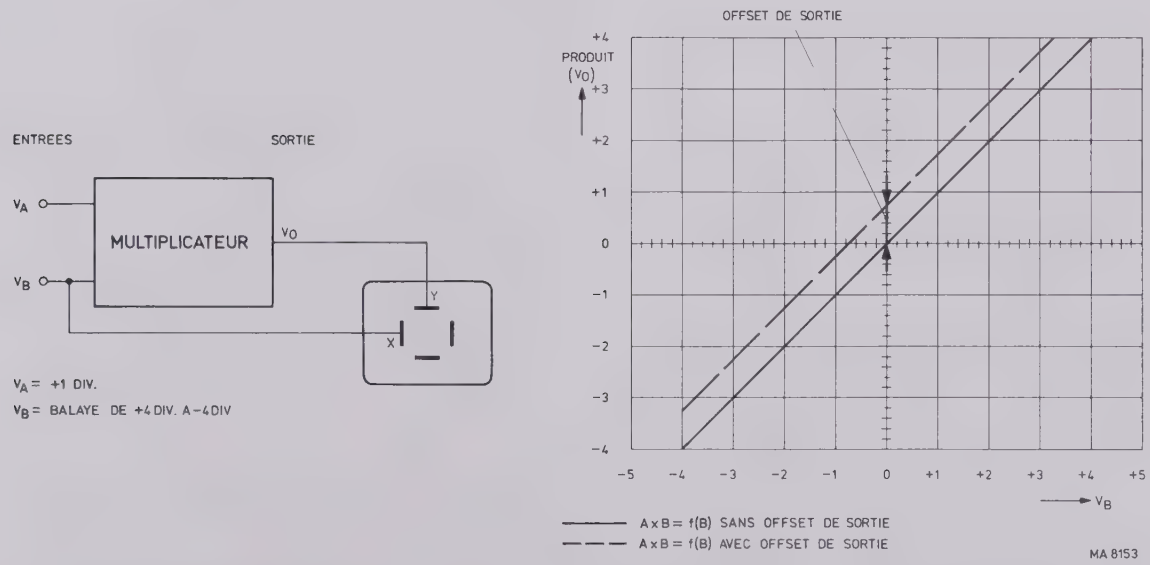
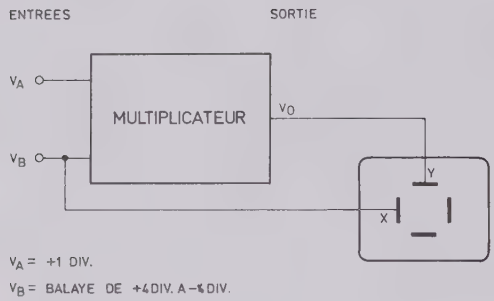


Fig. 1.6. Offset de sortie

La tension offset de sortie est une tension indésirable à la sortie du multiplicateur lorsque les signaux d'entrée sont nuls. Cette tension de sortie est visible comme une dérive verticale du produit affiché.

7. Facteur d'échelle



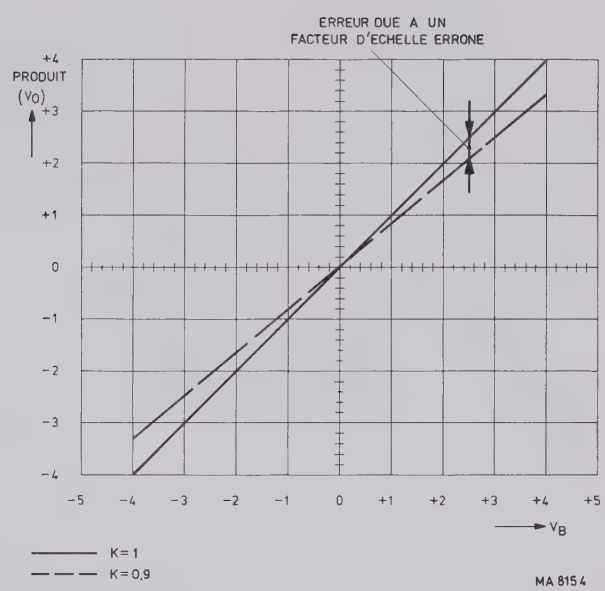
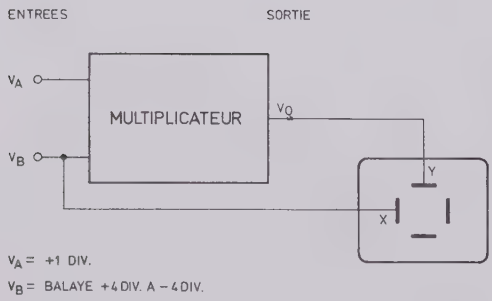


Fig. 1.7. Facteur d'échelle

L'échelle K est la constante de proportionnalité marquant le rapport entre la déflexion du tube à rayons cathodiques et les entrées A et B en mode MULT.

8. Non-linérité



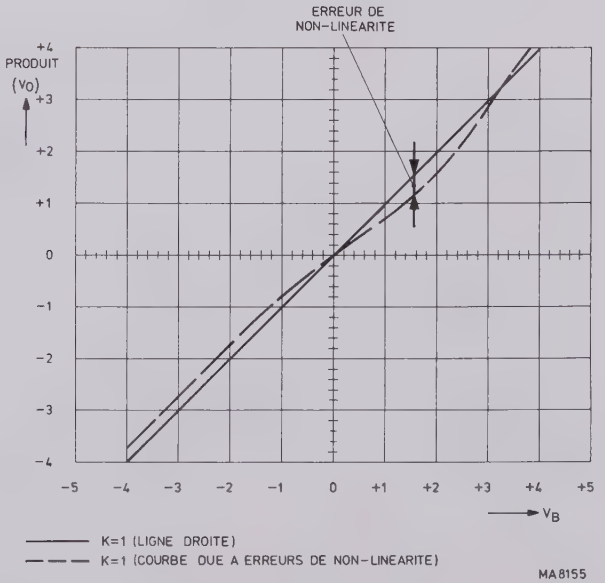


Fig. 1.8. Non-linéarité

La non-linéarité est la déviation de crête (A x B) = f (B) à partir d'une ligne droite idéale. Elle est exprimée en pour-cent de la pleine déviation d'écran.

9. Fuite

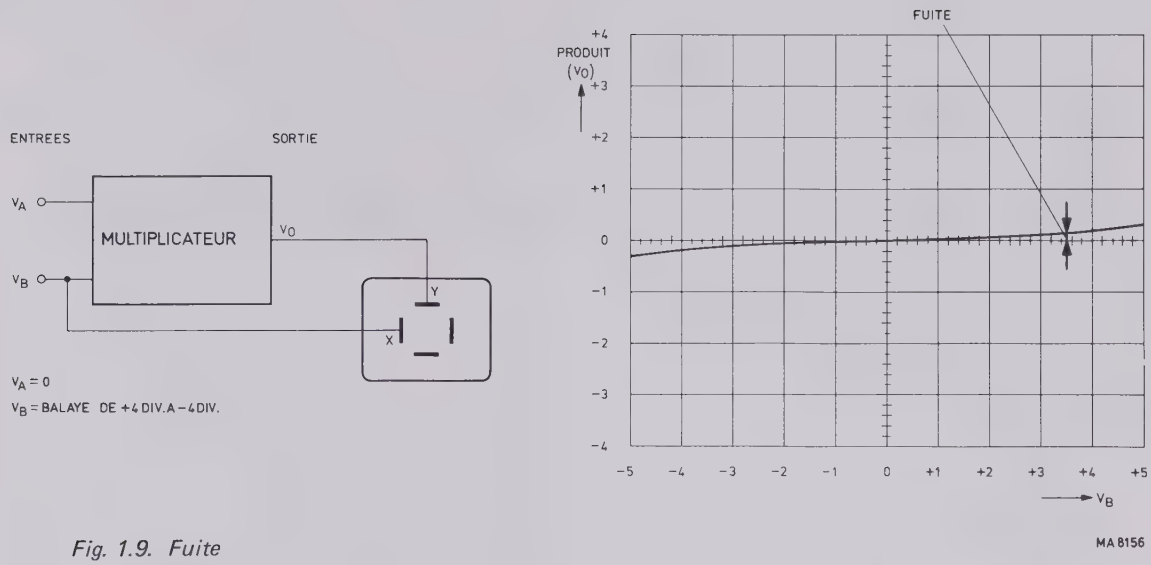


Fig. 1.9. Fuite

La fuite est la tension alternative à la sortie du multiplicateur lorsque, après équilibrage de la tension offset d'entree, est maintenue à zéro et le siganl maximal est appliqué à l'autre.

10. Délai de propagation

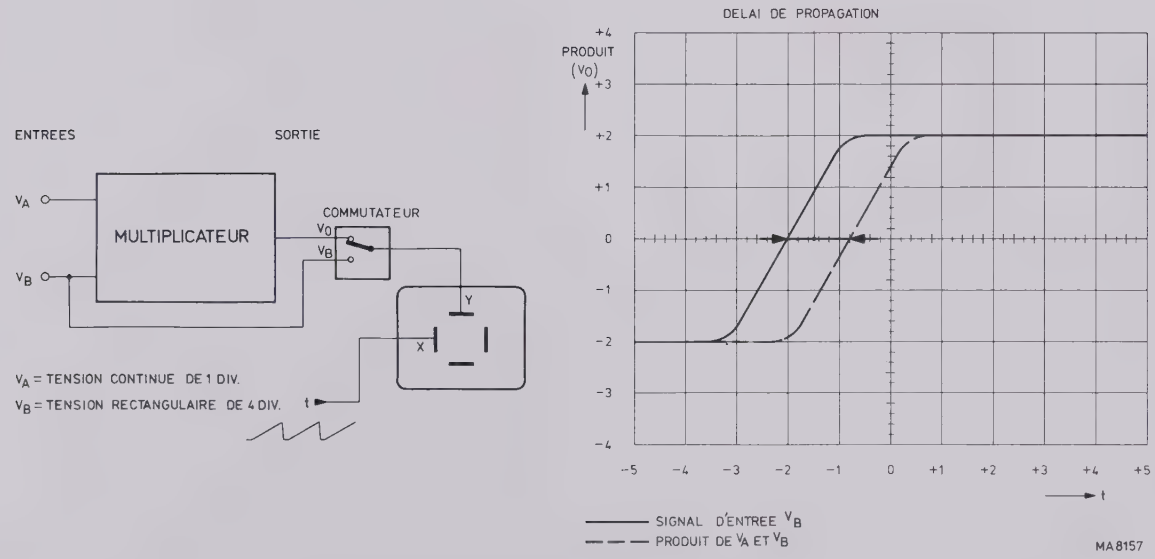


Fig. 1.10. Délai de propagation

Le délai de propagation est le délai entre les signaux de sortie et d'entrée dû au traitement des signaux d'entrée par le multiplicateu r.

11. Bruit

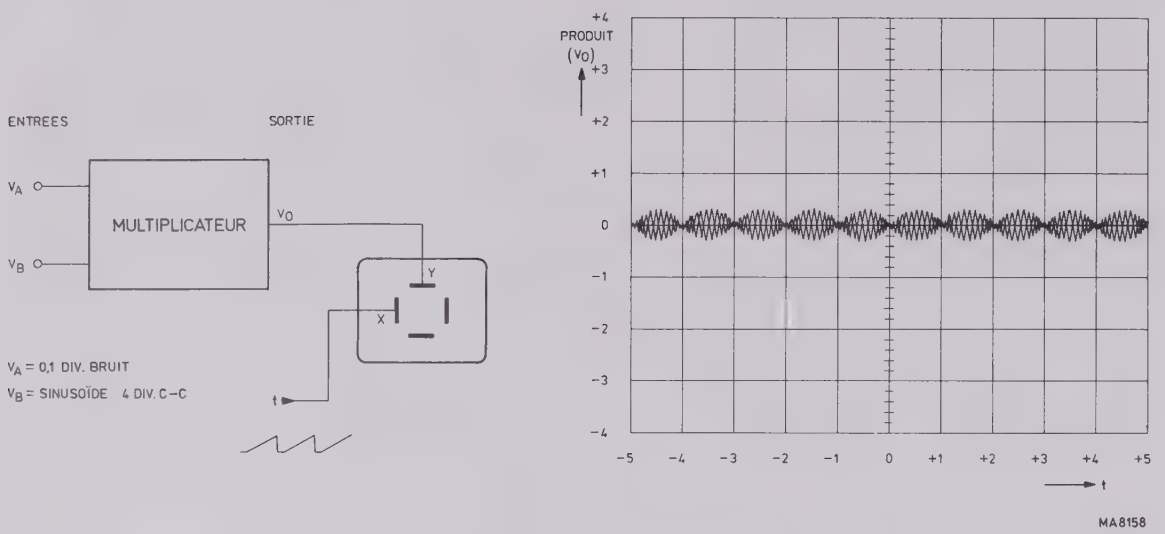


Fig. 1.11. Bruit

Le circuit multiplicateur ne produit pas beaucoup de bruit. Cependant, la tension d'entrée de A divisions sur un canal multiple le bruit présent sur l'autre canal.
Ceci cause une modulation et donc une ligne de base brisée.

12. Gamme dynamique d'entrée

Le signal maximal pouvant être appliqué aux entrées A et B sans influencer la linéarité.

13. Gamme dynamique de sortie

Le signal maximal pouvant apparaître à la sortie sans influencer la linéarité.

2. Mode d'emploi

2.1. INSTALLATION

Démontage et montage du couvercle frontal

Démontage:
- Tourner le bouton au centre du couvercle d'un quart de tour vers la gauche (position UNLOCKED)
- Enlever le couvercle

Montage:
- Tourner le bouton de verrouillage vers position UNLOCKED
  Fixer le couvercle sur la partie avant de l'oscilloscope
- Enfoncer le bouton et le tourner d'un quart de tour vers la droite (position LOCKED).

Des accessoires telles que sondes, visière repliable et autres peuvent être stockés dans le couvercle frontal. Pour accéder à cet espace exercer une pression sur les pattes de l'unité de verrouillage (voir Fig. 2.2.) et soulever la plaque.

Pour faire pivoter la poignée, il faut enfoncer les boutons-poussoirs aux étriers.

Attention: Avant de brancher l'appareil, la protection de terre doit être connectée à une connexion de terre. Le présent appareil produit des tensions élevées et ne peut donc pas être utilisé avec les plaques du châssis déposées. La fiche secteur doit être enlevée et tous les points haute tension déchargés avant de procéder à n'importe quel travail d'entretien.

Adaptation à la tension secteur et fusible

La capacité d'utilisation à toute tension secteur comprise entre 90 et 264 V alternatif ou entre 100 et 200 V continu supprime la nécessité d'adapter le PM 3243 à la tension secteur locale.
Le porte-fusible monté sur le panneau arrière porte un fusible à action retardée de 2 A. L'utilisation de fusibles réparés et le court-circuitage de porte-fusibles sont vivement déconseillés.

Mise à la terre

Avant toute mise sous tension, l'appareil doit être connecté à la terre de l'une des manières suivantes:

Par la borne de terre de l'appareil (symbole ⏚)
Par le cordon secteur à trois conducteurs. La fiche secteur ne doit être introduite que dans une prise possédant un contact de terre. La mise à la terre ne doit pas être éliminée par l'emploi d'un câble prolongateur sans conducteur de terre.

Attention: Toute interruption de la ligne de terre, à l'intérieur ou à l'exterieur de l'appareil ou le débranchement de la borne de terre peuvent rendre l'appareil dangereux. L'interruption intentionnelle est formellement interdite.
Lorsqu'un appareil passe d'un endroit froid à un endroit chaud, la condensation peut provoquer un certain risque. En conséquence, il faut appliquer strictement les prescription de mise à la terre.

Enclenchement

Le commutateur POWER est incorporé dans la commande INTENS (panneau avant), juste sous le bord de l'écran.

> **ATTENTION**
>
> **UNE FORTE INTENSITE DE LONGUE DUREE PEUT ENDOMMAGER LE TRC.**

En mode de persistance variable, le TRC indique que l'intensité est trop forte par expansion du point ou de la trace.
Dans ce cas, l'intensité doit être diminuée en tournant le bouton INTENS légèrement vers la gauche.
En position MEMORY OFF et en mode X-Y, aucune indication n'est donnée, aussi faut-il prêter une attention toute particulière.

Fig. 2.1. Dépose du couvercle frontal

Fig. 2.2. Ouverture du couvercle frontal

2.2. FONCTIONS DES COMMANDES ET CONNECTEURS

Déviation verticale

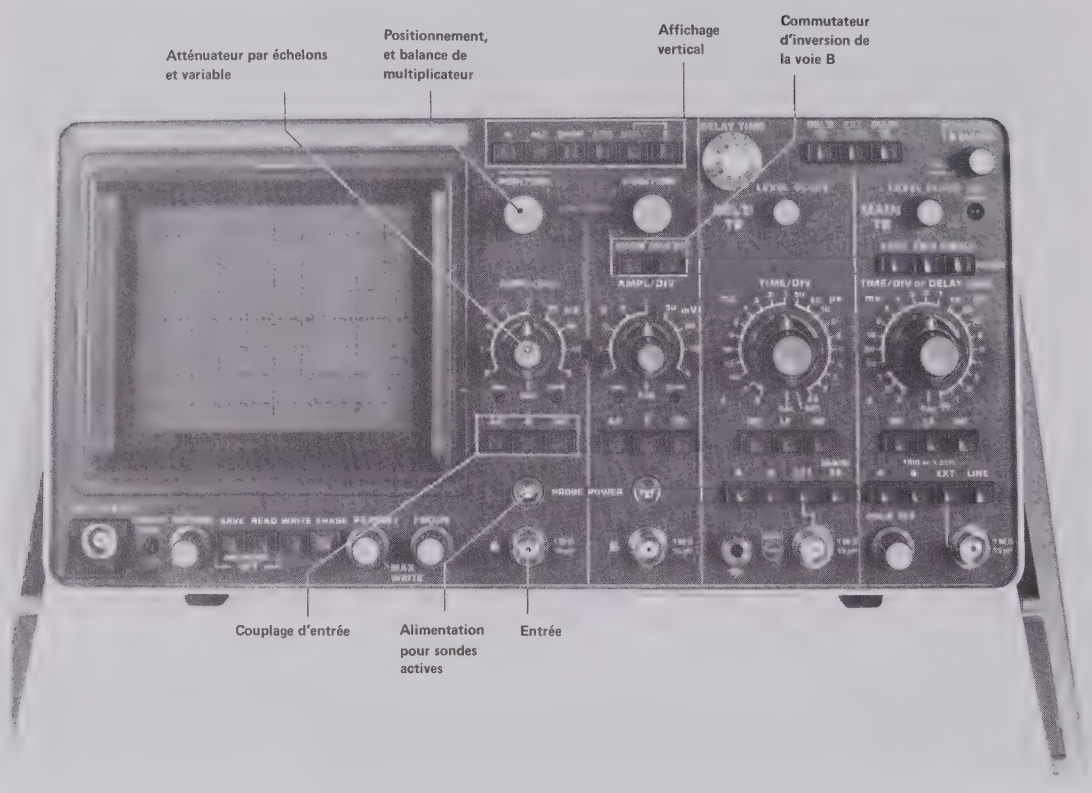


Fig. 2.3. Déviation verticale

Commutateur de déviation verticale	Commandes du mode d'affichage; sélecteur à 6 boutons-poussoirs
A enfoncé	La déviation verticale est obtenue seulement par le signal appliqué à l'entrée de la voie A.
ALT enfoncé	L'affichage est permuté d'une voie verticale à l'autre, et ce à la fin de chaque cycle du signal de base de temps.
CHOP enfoncé	L'affichage est permuté d'une voie verticale à l'autre à une fréquence fixe.
ADD enfoncé	La déviation verticale est obtenue par la somme des signaux A et B.
MULT enfoncé	La déviation verticale est obtenue par le produit des signaux A et B.
B enfoncé	La déviation verticale est obtenue seulement par le signal appliqué à l'entrée de la voie B. Si aucun bouton-poussoir n'est enfoncé, l'appareil fonctionne sur la voie A.
MULT + B enfoncées simultanément	L'affichage est commuté entre MULT et B (mode CHOP).
POSITION , et balance de multiplicateur (0 x A ou 0 x B)	Commande continuellement variable pour le positionnement vertical des traces. PUSH FOR BAL pour balance de multiplicateur (compensation d'offset)
NORM/INVERT	Commutateur push-pull pour l'inversion de la polarité de signal d'entrée (seule voie B). Si aucun n'est enfoncé, cela équivaut à NORM enfoncé.
AMPL/DIV	Commutateur à 9 positions des coefficients de déviation verticale.

AMPL./CAL	Commande continûment variable des coefficients de déviation verticale. En position CAL. le coefficient de déviation est étalonné
BAL (accessible par tournevis)	Commande continûment variable pour l'équilibrage en tension continue des amplificateurs verticaux.
GAIN (accessible par tournevis)	Commande continûment variable du gain des voies verticales.
AC/0/DC	Mode de couplage du signal d'entrée, commutateur à trois boutons-poussoirs.
AC enfoncé	Couplage par l'intermédiaire d'un condensateur de liaison.
0 enfoncé	La connexion entre l'entrée de l'amplificateur et la prise d'entrée est interrompue et l'entrée de l'amplificateur est mise à la terre.
DC enfoncé	Couplage direct. Si aucun bouton n'est enfoncé, on obtient le même effet que lorsque le bouton AC est enfoncé.
A 1 MOhm - 15 pF	Prise d'entrée BNC pour voie A
B 1 MOhm - 15 pF	Prise d'entrée BNC pour voie B.

Déviation horizontale

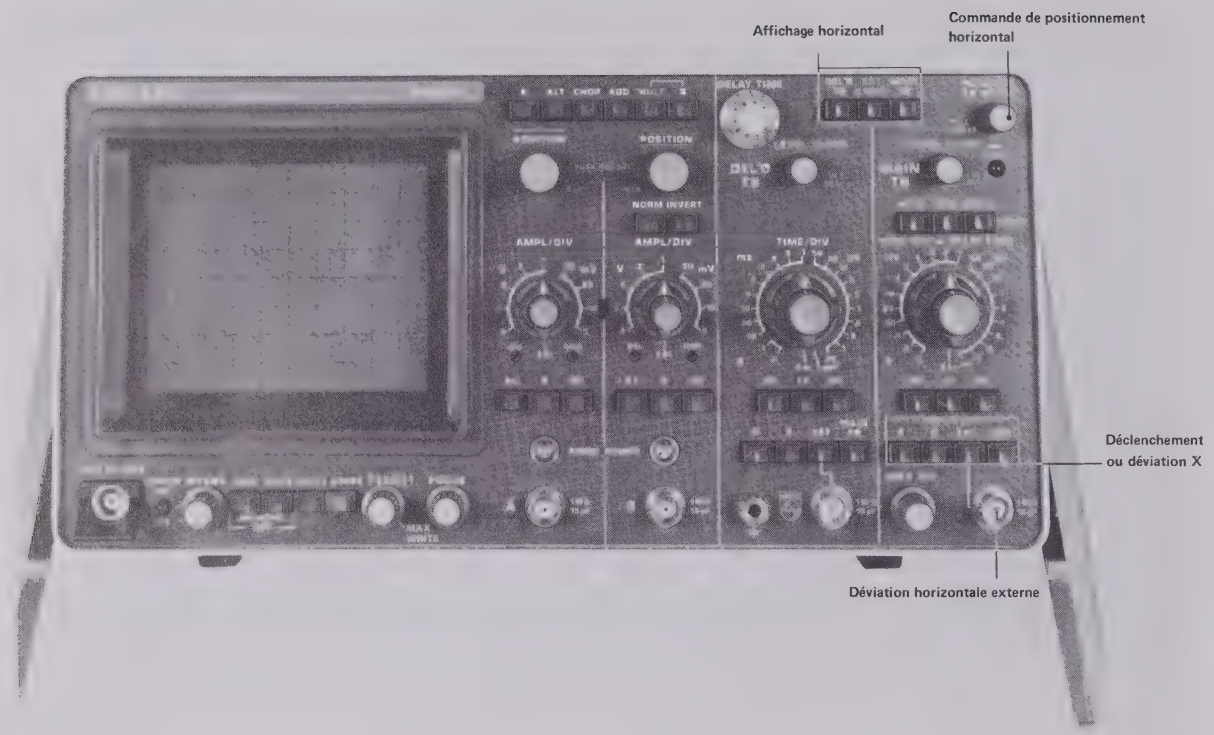


Fig. 2.4. Déviation horizontale

Commutateur de déviation horizontal	Commandes de déviation horizontale; sélecteur à 4 boutons-poussoirs.
MAIN TB enfoncé	La tension de déviation horizontale est fournie par le générateur de base de temps principale. Une partie de la trace est intensifiée (sauf en position OFF du commutateur TIME/DIV du générateur de base de temps retardée). Si aucun bouton n'est enfoncé, on obtient le même effet que lorsque le bouton MAIN TB est enfoncé.
EXT. X DEFL enfoncé	Le déviation horizontale peut être obtenue par un signal d'origine extérieure appliqué à la prise d'entrée de l'amplificateur horizontal par le signal de voie A, par le signal de voie B, par un signal externe ou par un signal à la fréquence du secteur.
DEL'D TB enfoncé	La déviation horizontale est fournie par le générateur de base de temps retardée.
TRIG ou EXT X DEFL	En mode de base de temps, la base de temps principale peut être déclenchée par: A — Signal interne de la voie A B — Signal interne de la voie B EXT — Signal appliqué à l'entrée de déclenchement LINE — Tension réseau (secteur), interne.
POSITION TB MAGN	Commande continûment variable pour le positionnement horizontal des traces; cette commande comprend un commutateur push-pull que augmente le coefficient de déviation horizontale d'un facteur 5. L'agrandisseur est hors service au cas où un signal de déviation X externe est appliqué.

Base de temps principale

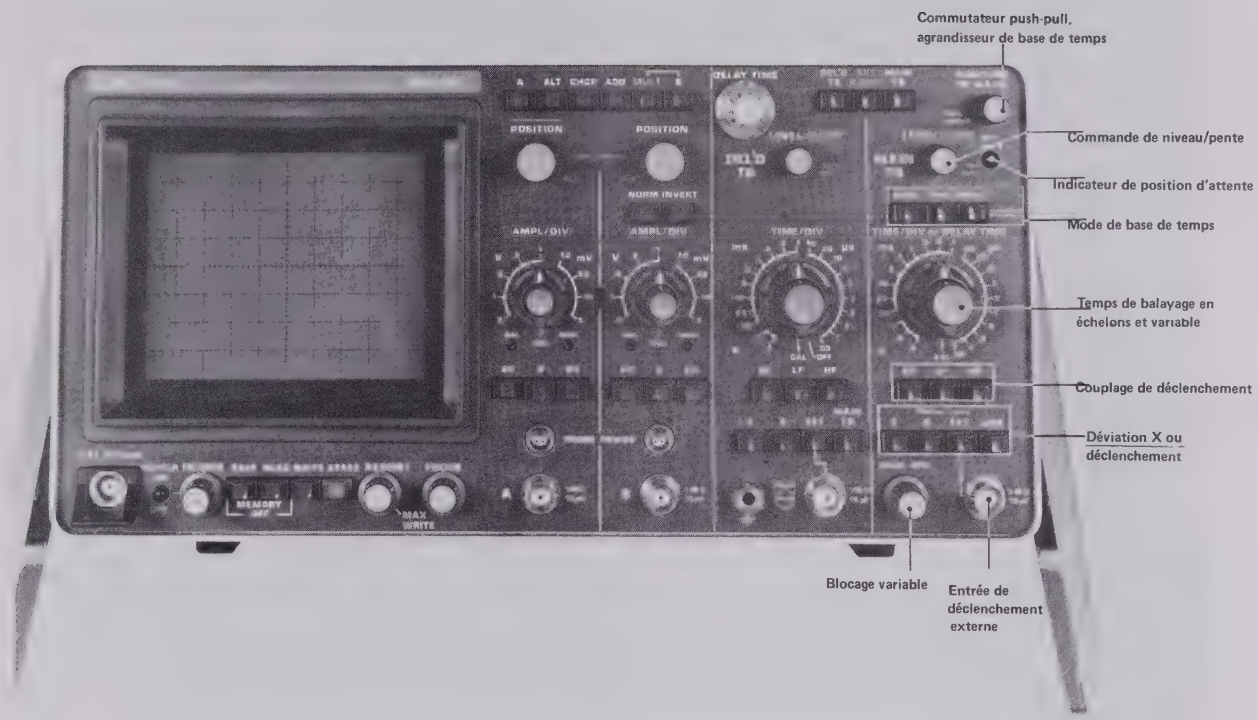

Commutateur push-pull, agrandisseur de base de temps
Commande de niveau/pente
Indicateur de position d'attente
Mode de base de temps
Temps de balayage en échelons et variable
Couplage de déclenchement
Déviation X ou déclenchement
Blocage variable
Entrée de déclenchement externe

Fig. 2.5. Base de temps principale

LEVEL SLOPE	Commande continûment variable pour sélectionner le niveau du signal de déclenchement, auquel le générateur de base de temps principale démarre. Cette commande comprend un commutateur push-pull, qui permet de déclencher sur le front positif ou negatif du signal de déclenchement.
NOT TRIG'D	Lampe témoin qui s'allume lorsque le générateur de base de temps principale est en position d'attente.
AUTO-TRIG-SINGLE	Commande de mode de déclenchement; commutateur à trois boutons-poussoirs.
AUTO enfoncé	Le générateur de base de temps principale est en fonctionnement libre en l'absence de signaux de déclenchement.
TRIG enfoncé	Le générateur de base de temps est déclenché normalement.
SINGLE enfoncé	Le générateur de base de temps ne démarre qu'une seule fois à la réception d'une impulsion de déclenchement. Si aucun bouton n'est enfoncé, l'appareil fonctionne en mode SINGLE Si aucun affichage n'est obtenu avec l'appareil enclenché et un signal d'entrée est appliqué, vérifier si le mode AUTO ou TRIG a été sélectionné pour la base de temps principale.
TIME/DIV or DELAY TIME	Commande de la vitesse de balayage de la base de temps principale; commutateur rotatif à 23 positions.
TIME/DIV-CAL	Commande continûment variable de la vitesse de balayage de la base de temps principale. (En position CAL, la vitesse de balayage est étalonnées)
DC/LF/HF	Choix du couplage de déclenchement: commutateur à 3 boutons-poussoirs
DC enfoncé	Les signaux de déclenchement sont couplés directement.

LF enfoncé	Couplage par le filtre passe-bas pour des fréquences allant jusqu'à 50 kHz (de 10 Hz à 50 kHz pour déclenchement externe).
HF enfoncé	Couplage par un filtre passe-haut pour des fréquences supérieures à 50 kHz. Si aucun bouton-poussoir n'est enfoncé, on obtient le même effet que si la touche DC était enfoncée.
TRIG or X DEFL	Commutateur à 4 boutons-poussoirs qui permet de sélectionner ou la source de déclenchement ou la déviation X par une source extérieure
A enfoncé	Signal de déclenchement interne ou de déviation X provenant de la voie A.
B enfoncé	Signal de déclenchement interne ou signal de déviation X provenant de la voie B.
EXT enfoncé	Déclenchement par un signal externe appliqué à la prise adjacente 1 MOhm - 15 pF. Lorsque le bouton EXT X DEFL des commandes de déviation horizontale est enfoncé, cette prise est connectée à l'entrée de l'amplificateur horizontal.
LINE enfoncé	Signal de déclenchement ou de déviation X provenant d'une tension interne à la fréquence du secteur. Si aucun bouton-poussoir n'est enfoncé, on obtient le même effet que si le bouton A était enfoncé.
1 MOhm - 15 pF	Prise BNC pour déclenchement externe ou déviation horizontale.

Base de temps retardée

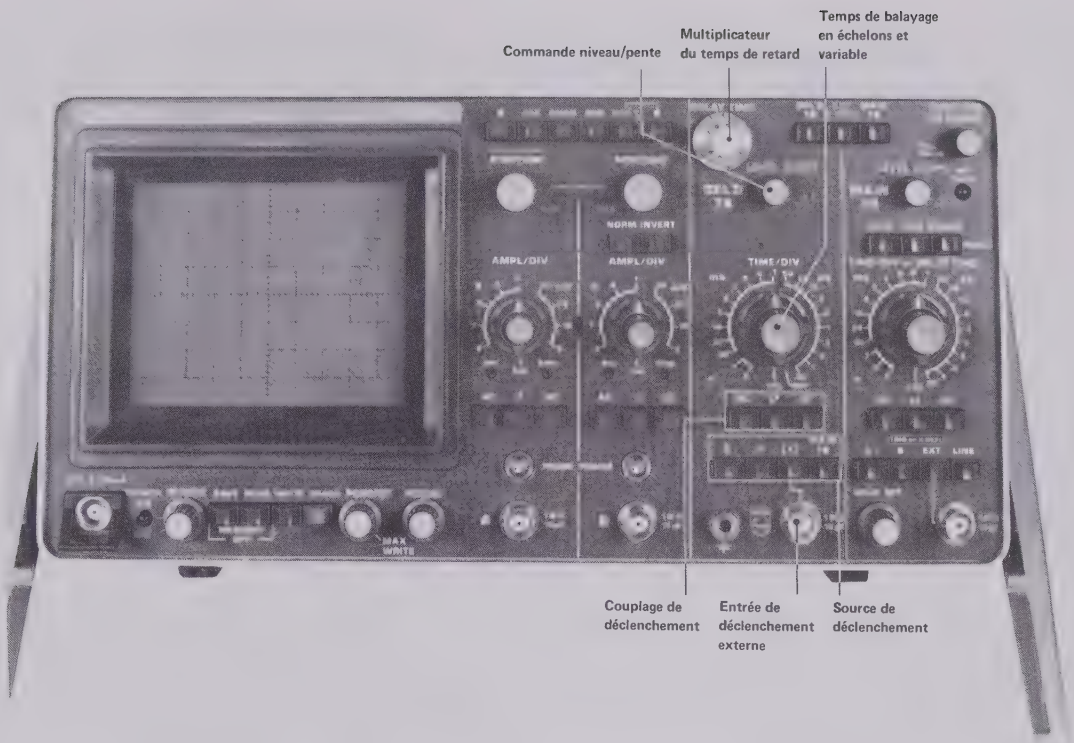


Fig. 2.6. Base de temps retardée

DELAY TIME	Commande étalonnée continûment variable du temps de retard, utilisée en association avec les commandes TIME/DIV du générateur de base de temps principale.
LEVEL SLOPE	Commande continûment variable qui permet de sélectionner le niveau du signal de déclenchement auquel le générateur de base de temps retardée démarre. Cette commande comprend un commutateur push-pull qui permet de démarrer sur le front positif ou négatif du signal de déclenchement.
TIME/DIV	Commande du coefficient de temps pour base de temps retardée; commutateur rotatif à 22 positions. Comprend une position OFF, grâce à laquelle le générateur de base de temps retardée est déclenché.
TIME/DIV -CAL	Commande continûment variable du coefficient de temps de la base de temps retardée. En position CAL, le coefficient de temps du commutateur est étalonné.
DC/LF/HF	Couplage de déclenchement; commutateur à 3 boutons-poussoirs.
DC enfoncé	Les signaux de déclenchement sont couplés directement.
LF enfoncé	Couplage par un filtre passe-bas pour les fréquences jusqu'à 50 kHz (pour le déclenchement par un signal exterieur, le filtre passe-bas agit de 10 Hz à 50 kHz).
HF enfoncé	Couplage par un filtre passe-haut pour fréquences supérieure à 50 kHz. Si aucun bouton n'est enfoncé, on obtient le même effet que si le bouton DC était enfoncé.
A/B/EXT	Commande de la source de déclenchement; commutateur à 3 boutons-poussoirs.
A enfoncé	Signal de déclenchement interne prélevé de la voie A après temps de retard.
B enfoncé	Signal de déclenchement interne prélevé de la voie B après temps de retard.

EXT enfoncé	Déclenchement après temps de retard par application d'un signal externe à la douille adjacente 1 MOhm - 15 pF. Si aucun bouton n'est enfoncé, on obtient le même effet que si le bouton A était enfoncé.
MAIN TB enfoncé	Base de temps retardée est demarrée immédiatement après le temps du retard.
1 MOhm - 15 pF	Prise d'entrée BNC pour le signal de déclenchement externe.

Tube à rayons cathodiques

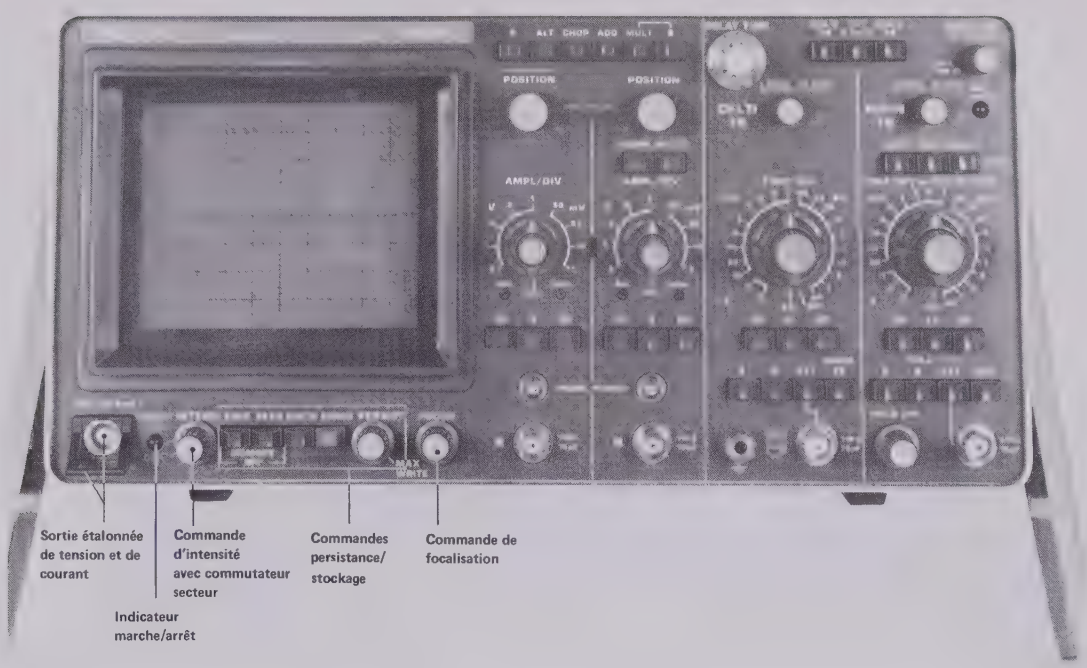

Sortie étalonnée de tension et de courant
Indicateur marche/arrêt
Commande d'intensité avec commutateur secteur
Commandes persistance/ stockage
Commande de focalisation

Fig. 2.7. Tube à rayons cathodiques

CAL	Douille de sortie, tension rectangulaire 3 V_{CC} pour étalonner la commande AMPL et réponse de fréquence des sondes de diviseur de tension. Boucle de courant 6 mA_{CC} pour étalonner les sondes de courant.
POWER ON/OFF	Témoin indiquant que l'appareil est en/hors service.
INTENS	Commande continûment variable de la luminosité, combinée avec le commutateur POWER ON/OFF.
FOCUS	Commande continûment variable de la focalisation du faisceau électronique.
Commandes persistance/stockage	
SAVE/READ/WRITE/ERASE	Mémorisation d'onde: sélecteur à 4 boutons-poussoirs.
SAVE enfoncé	Permet de mémoriser une onde pour visualisation prolongée (protégé contre l'effaçage accidentel).
READ enfoncé	Permet d'observer une onde (protégé contre l'effaçage accidentel).
MEMORY OFF (SAVE + READ) enfoncés	Permet le fonctionnement de l'appareil comme oscilloscope normal.
WRITE enfoncé	Permet d'enregistrer l'onde; dans ce mode la commande PERSISTANCE est hors service.
ERASE enfoncé	Permet d'effacer l'affichage en mode WRITE. Si la base de temps est en mode de balayage SINGLE (simple), ce commutateur remet également la base de temps en position originale.

Panneau arrière

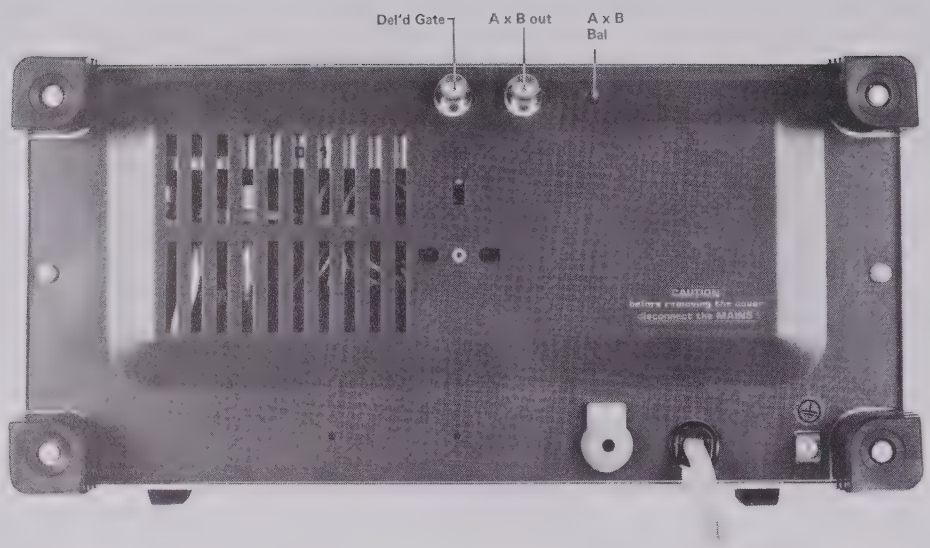


Fig. 2.8. Panneau arrière

DEL'D GATE	Sortie de porte de la base de temps retardée; TTL compatible. Logic '1' pendant les temps de fonctionnement de la base de temps principale intensifiée et de la base de temps retardée. Pour application du multiplicateur.
A x B OUT	Sortie de multiplicateur non-intégrée à couplage continu.
A x B BAL	Compensation d'offset de la balance de sortie pour multiplicateur.
FUSE	2 A lent pour toute tension d'alimentation
Cordon secteur avec fiche Terre de protection.	

2.3. REGLAGES PRELIMINAIRES

Avant d'effectuer des mesures avec l'appareil, il faut contrôler et adjuster les fonctions suivantes:

- Balance d'atténuateur par échelons.
- Réglage du gain.
- Balance de multiplicateur (0 x A, 0 x B).
- Balance de sortie pour multiplicateur.

Etant donné que les deux premiers réglages suivants sont identiques pour les deux voies verticales, seul le processus pour la voie A est décrit.

1. Balance d'atténuateur par échelons

- Enfoncer le bouton MAIN TB du sélecteur de mode de déviation horizontale.
- Enfoncer le bouton AUTO du sélecteur de mode de base de temps principale.
- Régler les commandes INTENSITY et FOCUS afin d'obtenir une trace nette et fine.
- Enfoncer le bouton de la voie requise du sélecteur de mode de déviation verticale.
- Enfoncer le bouton 0 du commutateur de couplage d'entrée.
- Régler le bouton POSITION de sorte que la trace se situe environ au centre de l'écran.
- Mettre la commande continue AMPL. sur CAL.
- Vérifier si la trace ne saute pas lorsque le commutateur par échelons AMPL. est tourné.
- Au besoin, ajuster la commande BAL.

2. Réglage du gain

Sauf indication contraire, les commandes occupent la même position que pour le processus de réglage précédent.

- Mettre le commutateur AC-0-DC sur AC
- Mettre le bouton AMPL. sur .5 V et la commande continue sur CAL.
- Connecter l'entrée de la voie à la sortie CAL.
- Vérifier si la déviation verticale est de 6 divisions exactement. Au besoin, ajuster la commande GAIN.
- Une sonde atténutarice peut être utilisée à cet étalonnage. Il faut tenir compte du facteur d'atténuation de sonde par rapport à la position du comutateur AMPL.

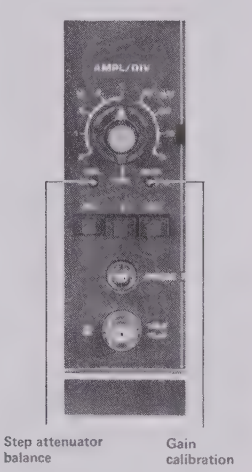


Fig. 2.9.

3. Balance de multiplicateur 0 x A, 0 x B

Si A ou B est multiplié par 0, le produit doit être nul. Les tensions d'offset aux entrées du multiplicateur peuvent encore causer certaine déviation sur l'écran. Pour les réduire, procéder comme suit:

Remarque: Les commandes 0 x A et 0 x B sont actionnées en enfoçant les boutons POSITION.

- Attendre un temps de chauffage de 15 minutes au moins, de 30 minutes de préférence.
- Appliquer un signal alternatif à amplitude dans la gamme dynamique spécifiée pour entrée A et B.
- Enfoncer le bouton MULT des commandes de mode d'affichage.
- Enfoncer le bouton-poussoir 0 des commandes de couplage de la voie A.
- Enfoncer le bouton-poussoir AC des commandes de couplage de la voie B.
- Régler la déviation minimale à l'aide du potentiomètre 0 x B sans modifier le réglage d'atténuateur.
- Enfoncer le bouton-poussoir AC des commandes de couplage de la voie A.
- Enfoncer le bouton-poussoir 0 des commandes de couplage de la voie B.
- Régler la déviation minimale à l'aide du potentiomètre 0 x A sans modifier le réglage d'atténuateur.

4. Balance de sortie A x B

Lorsqu'on utilise la sortie A x B à l'arrière, la sortie doit être nulle. Ceci peut être compensé par la commande A x B BAL près de cette sortie.
Procéder comme suit:

- Vérifier les réglages 0 x A et 0 x B comme indiqué au point 3.
- Enfoncer les deux commutateurs 0 des entrées A et B.
- Ajuster la commande A x B BAL à moins que la tension de sortie A x B soit nulle.

2.4. MANIPULATIONS

Généralités

Avant de brancher l'appareil, s'assurer que l'oscilloscope est installé correctement selon les instructions du chapitre 2.1. INSTALLATION et que les précautions décrites on été observées.
Pour utiliser l'oscilloscope en mode normal, donc sans mémoire, enfoncer les boutons-poussoirs SAVE et READ simultanément (MEMORY OFF).

Attention: Ne pas utiliser une intensité trop élevée en mode EXT X DEFL.

Entrées A et B et leurs possibilités

L'oscilloscope est pourvu de deux voies identiques, toutes deux pouvant être utilisées soit pour des mesures YT avec un ou deux générateurs de base de temps, soit pour des mesures XY avec la voie horizontale externe.

Mesures YT

Pour afficher un signal d'une des voies verticales, il suffit d'actionner le bouton-poussoir A ou B des commandes de mode d'affichage.
Lorsque le bouton-poussoir ALT ou CHOP est enfoncé, deux signaux différentes peuvent être affichés simultanément. Le coefficient de déviation Y peut être sélectionné pour chaque voie séparément. Lorsque le bouton ALT est actionné, l'affichage est commuté d'une voie à l'autre au retour du signal de base de temps. Quoique le mode ALT puisse être utilisé à toutes les vitesses de balayage du générateur de base de temps, le mode CHOPPED donne une meilleure qualité d'affichage pour des vitesses de balayage lents en effet pendant les temps de balayage longs, l'affichage alterné des deux signaux d'entrée est visible.

En mode CHOPPED, l'affichage est permuté d'une voie à l'autre à une fréquence fixe.
Si le bouton-poussoir ADD du commutateur de mode d'affichage est actionné, les signaux des deux voies verticales sont additionnées. En fonction des positions du commutateur de polarité de voie B, la somme ou la différence des signaux d'entrée est affichée. Le mode ADD permet également des mesures différentielles.

Mesures XY

Si les boutons-poussoirs EXT X DEFL des commandes de déviation horizontale et A des commandes TRIG or X DEFL sont actionnés, les générateurs de base de temps sont déconnectés. Un signal appliqué à la voie verticale A est alors utilisé pour la déviation horizontale lorsque le bouton A du commutateur TRIG or X DEFL est actionné. Le commutateur AC/0/DC et l'atténuateur par échelons de la voie A restent en service. La commande continue des coefficients de déviation est possible avec la commande continue AMPL et le décadrage de la trace horizontale avec la commande X POSITION.

La voie verticale B peut également être utilisée pour la déviation X pour ce faire, le bouton B des commandes TRIG or X DEFL doit être enfoncé.
Pour la déviation X, il est également possible d'utiliser une tension interne à la fréquence du secteur ou un signal extérieur appliqué à la douille EXT située sur la partie inférieure droite su panneau avec ceci, après avoir enfoncé le bouton-poussoir correspondant des commandes TRIG or X DEFL.

Commutateur AC/0/DC

Les signaux observés sont appliqués aux prises d'entrées A et/ou B et le commutateur AC/0/DC est réglé soit sur AC soit sur DC en fonction de la composition du signal. Du fait que l'amplificateur verticale est couplé directement, tout la bande passante de l'appareil est disponible et les composantes continues sont affichées comme des déclages de trace en position DC du commutateur AC/0/DC. Ceci ne peut pas convenir lorsque de petits signaux superposés à des tensions continues doivent être représentés. Chaque atténuation du signal résulte en une atténuation de la petite composante alternative.
Le remède à cet état est d'utiliser la position AC du commutateur d'entrée, lequel comprend un condensateur de liaison servant à supprimer les signaux continus. Lorsque des signaux rectangulaires à basse fréquence sont représentés, on obtient une certaine pente de toit.

En position 0 le signal est interrompu et l'entrée de l'amplificateur est mise à la terre, sur cette position, le niveau 0 V est rapidement déterminé.

Application du multiplicateur

Les signaux à multiplier doivent être appliqués aux bornes d'entrée A et B.

Gamme dynamique

Les deux multiplicandes A et B doivent se trouver dans les limites de la gamme dynamique des circuits multiplicateur et pré-amplificateur.
Etant donné qu'une condition de surcharge pour ces circuits ne doit pas être nécessairement observée dans le produit affiché, veiller à maintenir chaque signal d'entrée dans la gamme dynamique spécifiée avec amplitude maximale de 8 div. c-c.
Pour le produit affiché l'amplitude maximale spécifiée est également de 8 div. c-c. Si la sortie maximale est excédée, un des signaux d'entrée doit être réduit en amplitude.

Niveau de sortie du multiplicateur

Le signal de sortie du multiplicateur est représenté par la voie A.
Le produit affiché doit normalement présenter une composante continue, même lorsque les deux signaux d'entrée sont composés de composantes alternatives. Il est donc important de connaître le niveau zéro du produit affiché.
En mettant un des commutateurs AC/0/DC en position 0 et en utilisant la commande POSITION de la voie A, la ligne zéro peut être décalée en position appropriée sur l'écran.

Utilisation mémoire/persistance

En partant de la position MEMORY OFF (SAVE et READ enfoncés simultanément) le mode PERSISTANCE/STORAGE peut être obtenu en enfonçant le bouton-poussoir WRITE, à condition que la commande INTENS soit réglée pour intensité appropriée de trace et la commande FOCUS sur netteté maximale.

Les fonctions des autres boutons sont:

PERSIST	En fonction de la position du potentiomètre PERSIST, une trace à disparition rapide est écrite sur fond vert (bouton en position extrême gauche) et une trace à disparition très lents sur fond noir (bouton en position "premier arrêt droite")'. La persistance peut être réglée de telle sorte que tout clignotement est supprimée à la représentation d'un signal basse fréquence. Pour un signal à faible taux de répétition et court temps de montée, la persistance peut être réglée pour remplir la trace et donc obtenir une représentation nette et constante.
SAVE	Si une trace particulière doit être retenue, on enfonce le bouton SAVE Dans ce cas, la trace est à peine visible.
READ	L'intensité de la trace mémoirisée est accrue en enfonçant le bouton READ. A noter cependant que la luminosité augmente aux dépens du temps de stockage.
ERASE	Lorsque la trace n'est plus nécessaire, elle peut être effacée en enfonçant le bouton ERASE. Il se peut que la trace n'ait pas disparu entièrement et plus particulièrement les parties affichées avec luminosité substantielle, Ceci peut être corrigé avec un appui prolongé sur le bouton ERASE.
MAX. WRITE	La vitesse d'écriture peut être accrue d'un facteur 10 environ en mettant la commande PERSIST en position MAX. WRITE (deuxième arrêt droite), de sorte que le comutateur incorporé est permuté. Le mode MAX. WRITE est requis pour brefs temps de balayage ou pur signaux à court temps de montée.

Déclenchement

Lorsqu'un signal doit être représenté, la déviation horizontale doit toujours être démarrée à un point fixe du signal, et ce afin d'obtenir une trace stationnaire. Le générateur de base de temps est donc démarré par des impulsions de déclenchement étroites produites dans l'unité de déclenchement et commandé par un signal qui peut provenir: d'un des signaux appliqués aux entrées verticales, d'une tension interne à la fréquence du secteur, ou une source extérieur.

Couplage de déclenchement

Trois méthodes de couplage de déclenchement sont possibles avec le commutateur DC/LF/HF. En positions HF et LF, la caractéristique de transfert est limitée.

En position DC, le signal de déclenchement reste inchangé.
En position LF, un filtre passe-bande de 0 Hz (10 Hz pour déclenchement externe) à 50 kHz est incorporé.
Cette position peut être utilisée pour réduire l'interference du bruit.
En position HF, un filtre passe-haut de 50 kHz est incorporé.
Cette position peut être utilisée pour réduire l'interference du ronflement par example.

Sélection de la source de déclenchement et réglage du niveau de déclenchement

Le signal de déclenchement est obtenu à partir de la voie A (bouton A enfoncé), de la voie B (bouton B enfoncé), d'une source externe (bouton EXT enfoncé) ou d'une tension interne à la frequence du secteur (bouton LINE enfoncé).
Le conformateur d'impulsions de déclenchement est un multivibrateur à double commande commuté par les signaux de sortie d'un amplificateur différential.
Le signal de déclenchement, est appliqué aux entrées de l'amplificateur différentiel de concert avec les tensions continues réglables avec le potentiomètre LEVEL.
En fonction du réglage LEVEL, une certain partie du signal de déclenchement est amplifiée par l'amplificateur différentiel.
Le multivibrateur est donc commuté à un point fixe du signal de déclenchement. Ceci signifie que, s'aidant de la commande LEVEL, il est possible de donner sa forme au signal de déclenchement (en cas de déclenchement interne A ou B égal à la forme du signal à représenter) et donc, de choisir le point où le multivibrateur sera commuté.
Le potentiomètre LEVEL est pourvu d'un commutateur push-pull qui permet la sélection de la pente de déclenchement.

Déclenchement automatique

Lorsque le bouton AUTO du commutateur AUTO- TRIG - SINGLE est enfoncé, et qu'aucune impulsion de déclenchement n'est disponible, le générateur de base de temps fonctionne librement.
La trace est alors toujours visible. Le mode AUTO peut être utilisé dans tous les cas où le mode TRIG est également applicable, à l'exception de signaux dont la fréquence est inférieure à 10 Hz et des trains d'impulsions ayant un temps supérieur à 100 ms.
Dès que des impulsions de déclenchement sont disponibles, le fonctionnement libre du générateur de base de temps est automatiquement achevé et le générateur est à nouveau déclenché.
Lorsque les boutons TRIG ou SINGLE sont actionnés, le circuit automatique est mis hors circuit. Le réglage LEVEL peut également être utilisé en mode AUTO.

Déclenchement du balayage en SINGLE

Lorsque des effets uniques sont observés (par photographie), il faut s'assurer qu'une seule dent de scie est engendrée, même si plusieurs impulsions de déclenchement doivent être produites après le phénomène en question. Il va de soi que la dent de scie simple en question doit être déclenchée par une impulsion de déclenchement. Pour ce faire, le bouton SINGLE doit être enfoncé. La première impulsion de déclenchement apparaissant après le relâchement du bouton démarre le générateur de base de temps, celui-ci est alors bloqué jusqu'à ce que le bouton SINGLE soit enfoncé à nouveau. La lampe NOT TRIG'D s'allume dès que le bouton SINGLE est relâché, et ce jusqu'à la fin de la dent de scie.
A noter qu'en mode de balayage SINGLE le bouton ERASE remet la base de temps.

Agrandisseur de base de temps MAGN

L'agrandisseur de base de temps est actionné par un commutateur push-pull à deux positions incorporé dans la commande POSITION horizontale. Lorsque ce commutateur est tiré en position x5, les vitesses de balayage du générateur de base de temps principale sont augmentées d'un facteur 5. Donc, en x1, (TB MAGN enfoncé) la portion du signal affichée sur une largeur égale à deux divisions au centre de l'écran ocuppe la largeur totale de l'écran en position x5. Chaque portion de la trace peut être raportée sur l'écran à l'aide de la commande de POSITION horizontale.
En position x5, le coefficient de temps est déterminé en divisant par 5 la valeur TIME/DIV.

Utilisation de la base de temps retardée

Lorsque le bouton MAIN TB des commutateurs d'affichage horizontal est enfoncé et que le bouton TIME/DIV (base de temps retardée) n'est pas en position OFF, une partie du signal de balayage de la base de temps principale est intensifié. De la sorte, il est possible de choisir une portion du signal affiché en vue d'une observation détaillée. La portion choisie est affichiée sur l'écran entier en enfonçant le commutatuer DEL'D TB.

Le temps de balayage de la portion intensifiée est fonction de la position du bouton TIME/DIV (base de temps retardée).
Le bouton central permet d'ajuster les temps de balayage entre les échelons. Pour les mesures de temps, ce bouton doit toujours être en position CAL.
Le temps de démarrage de la base de temps retardée est déterminé par les réglages du bouton multiplicateur 10-tours TIME/DIV or DELAY TIME (base de temps principale).
Si le sélecteur de déclenchement MAIN TB de la base de temps retardée est enfoncé, le temps de retard après lequel la base de temps retardée est démarrée, est le produit du réglage de commutateur TIME/DIV. (base de temps principale) par la position du bouton multiplicateur DELAY TIME.

Si, au lieu de MAIN TB, la base de temps retardée est déclenchée par A, B, ou EXT , la base de temps retardée démarre après ce temps de retard et à la réception d'une impulsion de déclenchement. Cette impulsion est fournie par l'unité de déclenchement du générateur de base de temps retardée. Cette position est utilisée pour éviter une instabilité de la base de temps, laquelle donne une représentation floue d'un détail. Cette instabilité peut faire partie du signal à analyser ou, pour des agrandissements extrêmes, être produite dans les circuits de base de temps.

Service data

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3.1. DESCRIPTION OF THE BLOCK DIAGRAM

Refer to Fig. 2.10

General information

The PM 3243 oscilloscope comprises the following parts:

- a dual-channel vertical deflection system with signal multiplication facility
- a main time-base
- a delayed time-base
- a switching unit
- an X amplifier
- a Z modulator and c.r.t. circuit with persistence storage facilities
- e.h.t. supplies
- a power supply

Dual-channel vertical deflection system

The A and B vertical channels are almost identical circuits. The main differences are that channel B has a switch facility for signal inversion, and in the multiplier mode the signal is routed via the A channel after multiplication
The input signal to each channel is fed via a three-position coupling switch AC/0/DC to the input attenuator.
In the AC position a capacitor is switched in series with the signal path. In the 0 position the input signal path is interrupted and the attenuator input is earthed.
The input attenuator, controlled by the AMPL/DIV switch via reed relays, enables the adjustment of the vertical deflection sensitivity in calibrated steps. This attenuator consists of a high and low impedance part separated by an impedance converter, with a drift-compensation circuit.
The d.c. balance of the entire channel is set by a BAL potentiometer which compensates for the d.c. offset voltage of the impedance converter.
The output signal of the attenuator is applied via a 50 Ohm coaxial cable to the intermediate amplifier where it is transformed into push-pull signal.
The intermediate amplifier provides the following functions:

- a signal for the trigger pre-amplifier
- GAIN calibration and BAL compensation controls
- shift for the Y trace by means of the POSITION control combined with 0 x A and 0 x B compensation controls
- electronic switching of the selected channel modes
- phase inversion of the B channel by means of the INVERT pushbutton.

The channel selector enables or inhibits the Y signals as dictated by the channel selection logic. In the A, B, ADD and MULT modes, the channel selector logic setting depends on the vertical display mode switch. In the ALT mode the channel selector logic is controlled by pulses derived from the sweep-gating multivibrator of the main time-base generator. In this way, the complete signal trace of channel A and channel B are alternately displayed on the c.r.t. screen.

In the CHOP mode, the channel selector control pulses are derived from an oscillator running at a fixed frequency of approximately 1 MHz. These pulses successively open and close the electronic switch in the channel selector so that portions of the signals of channel A and channel B are alternately and repetitively displayed.

In the MULT mode, the signals to be multiplied are taken out of the amplifier stages of channels A and B and are multiplied in the multiplier circuit. The resulting signal is amplified and re-inserted in the amplifier of channel A. If MULT and B pushbutton are simultaneously depressed, both signals are displayed in the CHOP mode.

A common output for the A and B channels feeds the delay line, which delays the vertical signals sufficiently to permit the steep leading edges of fast signals to be displayed. A delay-line correction circuit compensates for the distortion introduced by the delay line. A final stage feeds the Y signals to the vertical deflection plates of the c.r.t.

Time-bases

Main time-base

The trigger source/X deflection selector receives its signal from one of four sources:

- either A or B vertical channels via its trigger amplifier
- from the EXT input socket
- from the opto-isolator in the power supply.

Selection of these sources is by means of the four-pushbutton unit in this stage.

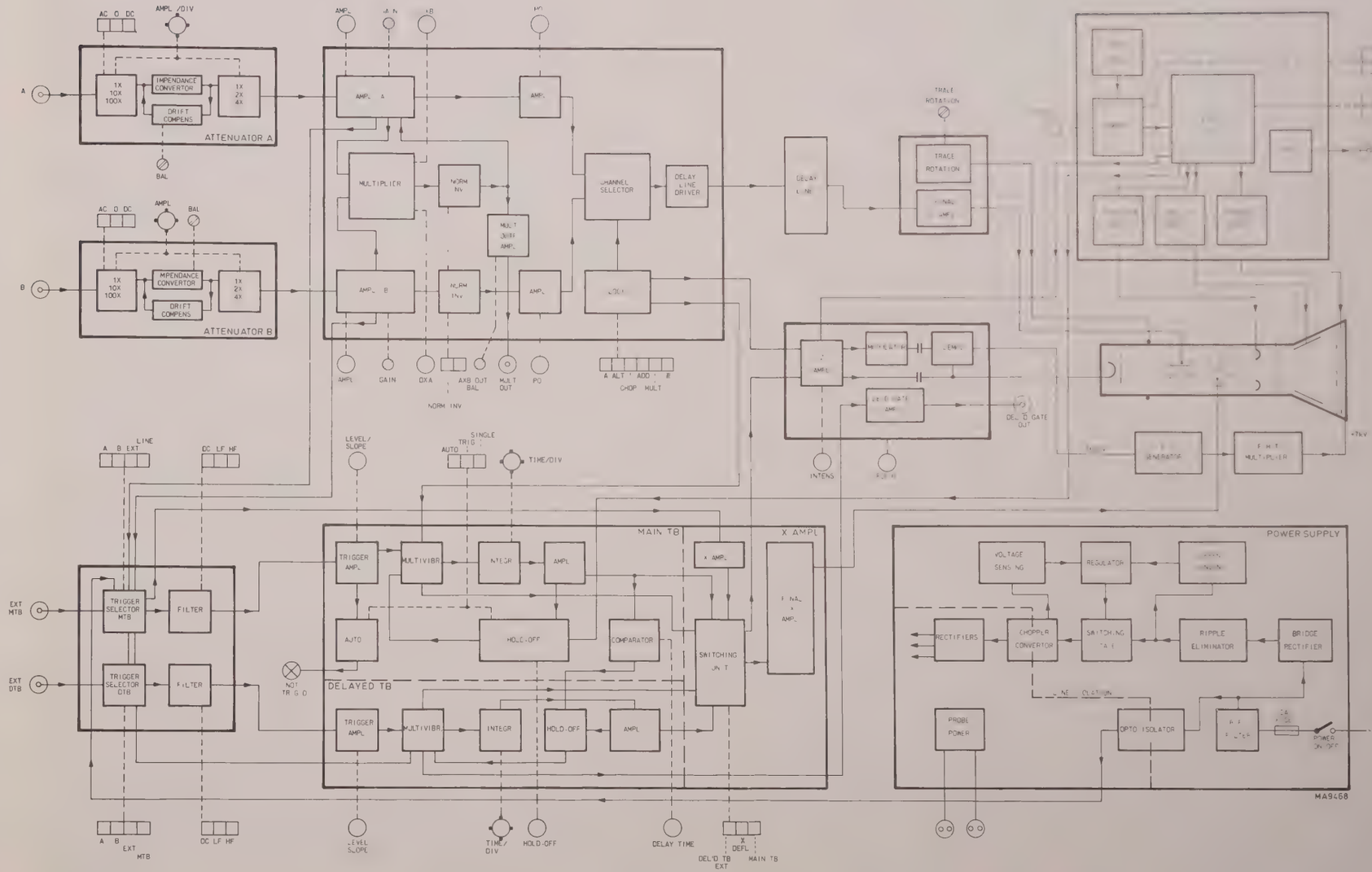


Fig. 3.1. PM 3243 block diagram

From the selector stage, the signal is fed to either the X pre-amplifier for horizontal deflection (when external X signal is employed), or the trigger amplifier for starting the time-base generator. The input of the trigger differential amplifier stage contains the control for selecting the input frequency range of the trigger circuit. The trigger LEVEL adjustment and SLOPE selection switch are also incorporated in this stage. The SLOPE selector switches the differential amplifier to invert the polarity of the trigger signal to enable triggering of the input signals on either positive or negative-going slopes.
The output of the trigger amplifier is applied to the trigger multivibrator, which produces well-defined trigger pulses. These trigger pulses are used to switch the sweep-gating multivibrator and, when the AUTO pushbutton has been selected, for driving the auto-circuit.

The sweep-gating multivibrator controls the starting and stopping of the integrator circuit that produces the sawtooth waveform required for the horizontal deflection.
The integrator circuit consists of charging capacitors switched by transistors, and the resistors selected by the TIME/DIV switch to set the time coefficients in calibrated steps. Continuous control of these time coefficients is obtained by varying the charging current of the time-determining capacitors by means of the TIME/DIV potentiometer.
The resulting sawtooth signal of the integrator is fed to the X deflection selector, the hold-off multivibrator and the comparator, which is part of the delayed time-base unit.
The hold-off multivibrator resets the sweep-gating multivibrator and inhibits its input during the flyback period of the sawtooth waveform. The hold-off circuit also incorporates the single sweep circuit that causes the main time-base to produce a single sawtooth waveform after the SINGLE pushbutton has been depressed and on receipt of a trigger pulse.

The automatic free-run circuit or auto-circuit makes the time-base free-running when no trigger pulses are applied.

Delayed time-base

If the MAIN TB of the horizontal display switched is depressed, and the delayed time-base TIME/DIV knob is not in the OFF position, part of the main time-base sweep line is displayed at higher intensity.
In this way, part of the displayed signal can be selected for more detailed observation. The selected part of the signal is displayed over the whole screeen by pressing the DELD'D TB switch.
The sweep time of the intensified part of the main time-base sweep depends on the delayed time-base TIME/DIV knob.
With the centre knob, sweep times between the steps can be adjusted. For time measurements this knob must always be in the CAL position.

The starting time of the delayed time-base is determined by the settings of the main time-base TIME/DIV OR DELAY TIME knob and the DELAY TIME 10-turn multiplier knob.

If the MAIN TB trigger selector switch of the delayed time-base is pressed, the delay time after which the delayed time-base is started, is the product of the main time-base TIME/DIV switch setting and the DELAY TIME multiplier knob.

If instead of MAIN TB, the delayed time-base is triggered by A, B or EXT , the delayed time-base will start after this delay-time and upon receipt of a trigger pulse.

In principle, the delayed trigger-unit and time-base generator use similar circuits to those of the main trigger-unit and time-base generator. The delayed time-base always operates in the single-shot mode. The sweep is initiated by the main time-base generator which also serves as hold-off for the delayed time-base.

The DELAY TIME control in conjunction with the comparator and reset multivibrator determine the delay time for the delayed time-base generator. The delayed time-base is operative unless its TIME/DIV control is in the OFF position. It starts immediately after the delay time, or upon receipt of the first trigger pulse after the delay time. It can be triggered by the A, or B channels, or externally.
When pushbutton MAIN TB of the horizontal deflection mode controls is depressed, the part of the trace coinciding with the delayed sweep is intensified.

Switching unit and X amplifier

The X deflection selector couples the external X deflection signal from the X (pre)amplifier, the output of the main time-base generator or the output of the delayed time-base generator to the X amplifier, which feeds the horizontal deflection plates. The X amplifier comprises the horizontal trace positioning and the x5 magnification controls.

The blanking pulse selector supplies blanking pulses to the Z amplifier. These pulses blank the trace at the end of the main time-base sweep and provide the extra bright-up pulse if the oscilloscope operates with a portion of the trace intensified. The blanking pulses during the switching of the traces in the chopped mode go direct from the channel selector logic to the Z amplifier.

CRT circuits and Z amplifier

The c.r.t. circuits include stages for trace blanking and unblanking, an automatic brightness control unit, circuits appertaining to the storage functions of the c.r.t. and networks for the correction of the c.r.t. characteristics. The automatic brightness control (a.b.c.) unit ensures a virtually constant trace brilliance or a blanked trace in various display modes.
In the continuous display mode, the trace is blanked and unblanked by a signal from the main time-base generator.
In the single-sweep mode, the trace is blanked via the a.b.c. unit.
The trace storage circuits provide the voltage levels and waveforms which are necessary for the storage operation of the c.r.t., under the control of the SAVE, READ, ERASE and WRITE pushbuttons.

The correction networks comprise preset potentiometers for trace rotation, astigmatism, flood gun filament potentials, distortion.
The high-voltage for the post-acceleration anode of the c.r.t. is supplied by a stabilized h.t. generator , the output of which is rectified and multiplied by a factor of 5.

The Z amplifier receives two input signals. One originates in the time-base generator and is applied, via the switching circuit, to the Z amplifier to blank the trace during flyback; the other is supplied by the channel selector logic to blank the trace during switching in the chop mode.

The INTENS potentiometer determines the amount of input current fed to the Z amplifier.
At the output of the amplifier, the signal is split into two parts: an l.f. + d.c. part and an h.f. part. The h.f. part is fed direct to the Wehnelt cylinder of the c.r.t. An oscillator signal is modulated by the l.f. + d.c. part and the composite signal is afterwards detected in a peak-to-peak detector. Both signals are combined again on the Wehnelt cylinder.
The focus control also forms part of the c.r.t. circuit.
The calibrator, an integral part of the oscilloscope, is a square-wave generator which supplies an accurate voltage and current for calibration purposes.

Stabilized power supply

The mains voltage is full-wave rectified and fed to a voltage regulator. The voltage regulator contains a current sensor which controls in such a way that the output voltages of the power supply stay within specified limits. The rectified mains voltage controls a blocking oscillator which generates a voltage at a frequency of approximately 20 kHz. This voltage is applied to the primary winding of a transformer. The secondary voltages of this transformer are full-wave rectified, smoothed and applied to the various circuits.

The LINE (MAINS) triggering signal is taken direct from the mains and, via an opto-isolator, fed to the trigger circuits at a safe level, completely isolated from the mains.

3.2. STORAGE TUBE

Storage principle

The information is stored by writing the signal of the main electron beam into a STORAGE LAYER of non-conductive material. As a result of the secundary emission of electrons from this layer, a positive charge pattern is formed. This charge pattern on the storage surface will remain there for a considerable length of time. The trace is displayed on the phosphor viewing screen by means of two flood beams whose electrons can strike the display-phosphor via the positively charged parts on the storage layer.

Storage of information on non-conductive material is based on secundary emission. Fig. 3.2. shows the ratio between the number of electrons leaving the storage layer and the number of electrons arriving (secundary emission ratio) versus the surface potential. At a certain surface potential, V_a in Fig. 3.2. the number of electrons leaving the surface equals the number of electrons arriving. This point is called the first cross-over (secundary emission ratio = 1).

If the surface of the storage layer is hit by electrons of higher energy (electrons with greater velocity), the surface will become more positive, since more electrons are leaving than arriving. If the surface is hit by electrons of lower energy (electrons with lower velocity) than at V_a, the surface potential becomes more negative, as fewer electrons are leaving than arriving.

Construction and operation of the storage c.r.t.

The storage cathode-ray tube contains two electron-gun systems: the WRITING system and the FLOOD system. The writing electron-gun system is in principle the same as in a normal cathode ray tube.

The FLOOD system consists of a pair of FLOOD GUNS operated in parallel. Both guns comprise a CATHODE k, a CONTROL GRID g1 and an ACCELERATOR GRID g2. Common to both flood guns are the FLOOD BEAM COLLIMATORS MESH g8, the STORAGE MESH g9 which carries the storage layer , and the PHOSPHOR VIEWING SCREEN g10. Refer to Fig. 3.3 and 3.30.

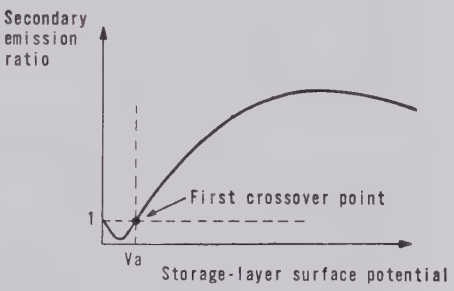


Fig. 3.2. Secondary emission ratio

The flood guns are located besides the horizontal deflection plates. The cathode potential is approx. 0 V, this being 50 V negative in relation to the accelerator grids. Both flood gun cathodes emit a cloud of electrons. These clouds are combined by both control grids g1, accelerated by both accelerator grids g2 and shaped by the collimator g7 which consists of a coating on the inner surface of the c.r.t. The positive voltage on the collimator is such that the electron cloud emanating from the flood gun just fills the viewing area of the c.r.t.

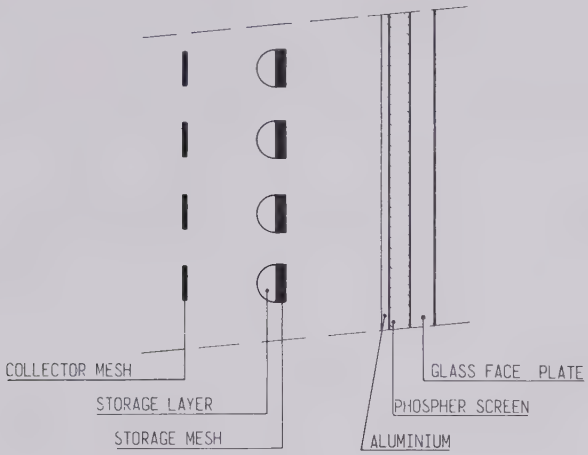
The cloud is further accelerated in the direction of the storage mesh and the display phospor g8. After passing through the collector mesh, the flood-gun electrons are controlled by the potentials on the storage layer surface.

Both meshes have been made from very thin material with 40 x 40 μm apertures. The cathode side of the storage mesh is coated with a non-conductive material on which the information is stored. In other words, there exists a capacitive coupling between the storage mesh and the storage-layer surface. The storage mesh is normally at a potential of approximately +1 V in relation to the flood-gun cathode potential, i.e. approximately +32 V with respect to earth.

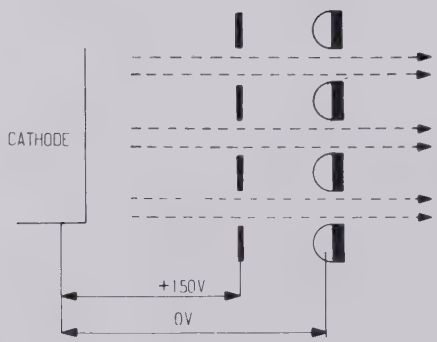
The potential V_a at the storage-layer surface is controlled by WRITE and ERASE signals which are applied to the storage mesh, and varies between 0 V positive and 8 V negative in relation to the flood-gun cathode. When the storage-layer surface is at a potential of 0 V in relation to the cathode (see Fig. 3.3.b.), the majority of flood-gun electrons pass through the holes in the mesh and reach the phosphor screen. The remaining electrons are repelled by the storage-layer surface and collected by the collector mesh. When the potential of the storage-layer surface is negative in relation to the cathode (see Fig. 3.3.c.), the number of electrons passing through the storage mesh is drastically reduced or, when the cut-off level is reached, no electrons pass at all (just black).

The post-accelerator voltage of approximately 7 kV is connected to the phosphor viewing screen. Electrons that are allowed to pass through the storage mesh are accelerated by this potential and strike the phosphor with such a velocity that a brilliant display is obtained.

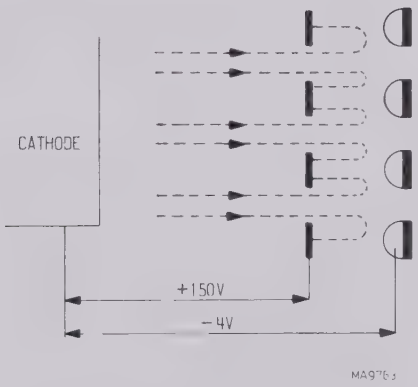
The storage-mesh may be compared to the grid of a triode. Just as the triode grid potential controls the anode current, the storage mesh controls the current of flood-gun electrons to the display phosphor.
If the var. persistance/storage functions are not operative the memory mesh is on a constant −36 V level.
The writing gun electrons fly through both meshes and reach the display phosphor. The flood-gun electrons are not getting through the memory mesh but are retracted by the collector mesh.



3.3.a. Detail of storage system



3.3.b. Full brightness storage



3.3.c. Storage cut-off

Fig. 3.3. Storage system details

3.3. CIRCUIT DESCRIPTION

Only the circuits of the PM 3243 which are additional to, or different from the basic PM 3240 oscilloscope are discussed.
For the remaining description and drawings refer to the basic PM 3240 manual.
All push-button switches in the circuit-diagrams have been drawn in the released position.

1. Variable persistence/storage

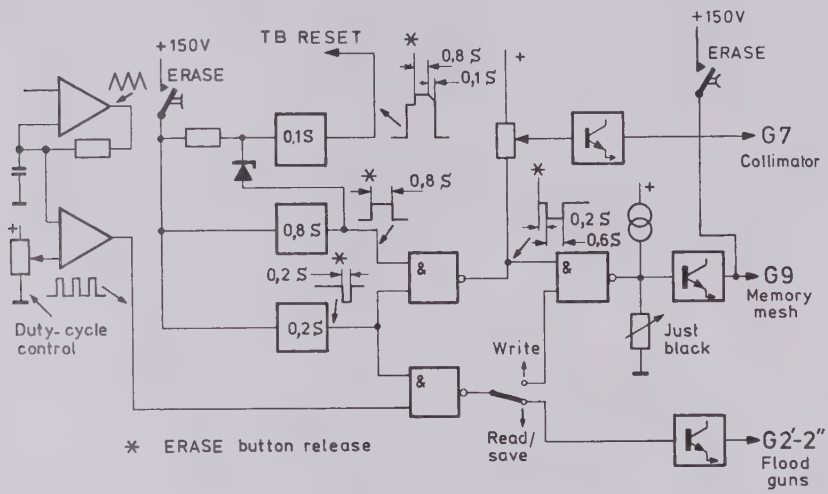


Fig. 3.4. Simplified circuit persistence/storage functions

Refer to circuit diagram Fig. 3.31.
Some wave-forms in this circuit are given in Fig. 3.32.
Fig. 3.4 shows the simplified circuit of the persistence/storage functions.

The IC 2101-A circuit forms a triangular-wave 2 kHz oscillator, which drives the variable duty-cycle generator IC 2101-B. The duty-cycle of the square-wave signal on the output of IC 2101-B depends on the PERSIST control and the position of the WRITE and SAVE switches.

a. WRITE mode

SK20-WRITE depressed.
The square-wave signal present on input 13 of IC 2102-D is applied to the emitter-folower TS 1211 via IC 1202-C.
TS 1211 feeds the memory-mesh (g9) of the cathode ray tube.
The duty-cycle of the signal on the memory-mesh depends on the PERSIST control (R15).
The voltage on the flood-gun accelerators (G2'-G2") is constant because TS 2114 is not conducting.
Z-modulation (current to R1394) is not inhibited because SK20 (10-11) is open.

b. SAVE and READ modes

The voltage on the memory-mesh is now constant because SK20 (2-3) is open.
On the flood-gun accelerators is now a square-wave voltage the duty-cycle of which controls the amount of flood-gun electrons.
Z-modulation is inhibited because R1394 is now connected to +12 V.

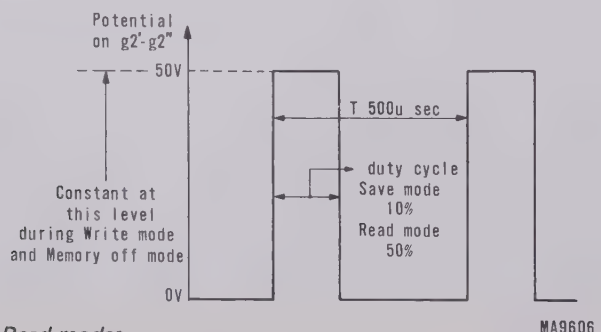


Fig. 3.5. Save and Read modes

SK20-SAVE depressed.
The duty-cycle of the flood-gun accelerator voltage is now 10% resulting in a just visible display. (This duty-cycle can be adjusted up to 50 % with preset pot. meter R2149 (SAVE) giving a brighter display but shorter store time). Factory set at 10 % for 15 min. store time.
SK20-READ depressed.
The duty cycle of the flood-gun accelerator voltage is now 50 % giving a useful display.

c. Manual ERASE mode

SK21-ERASE depressed (only operative in the WRITE mode).
If the ERASE button is depressed a constant +150 V voltage is applied to the memory mesh (via GR2105). Owing to the capacitive coupling between the surface layer and the mesh itself, the surface layer voltage rises the same voltage jump. By the high positive layer voltage, secondary emission takes place over the whole layer surface and all information on the storage layer is overruled.
The voltage over the whole layer surface will now reach approx. +150 V which is the potential of the collector mesh. If the local surface layer voltage would be lower the secundairy emission takes place until the voltage is reached.
The local surface layer voltage can not grow higher than +150 V because then the secundary emission electrons are then reflected by the collector mesh.
At the moment the ERASE button is released the surface layer voltage jumps approx. 150 V due to the capacitive coupling.

After a stable situation of approx. 200 ms, a +8 V pulse of approx. 600 ms is applied to the storage mesh. The surface layer which follows capacitively will now be sprayed by low-energy electron which do not cause secondairy emission but will bring the surface to a sufficient low voltage.
At the end of the 600 ms pulse the mesh voltage jumps 8 V which will bring the surface layer at approx. –8 V.

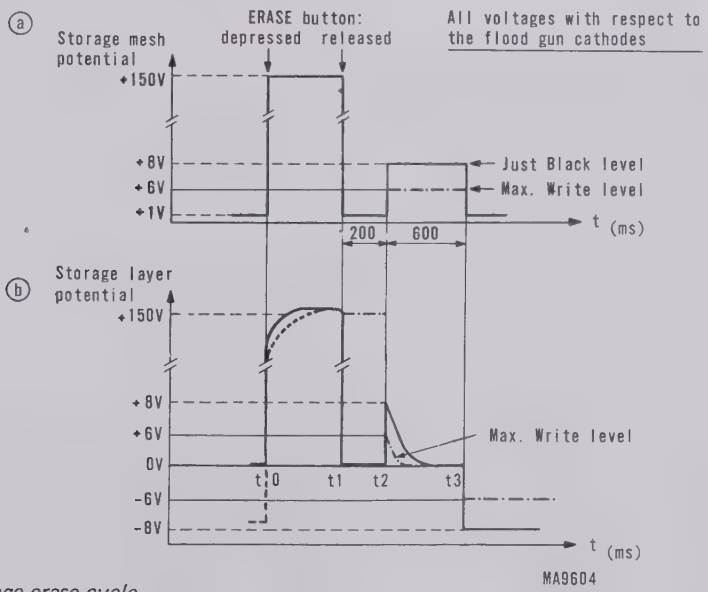


Fig. 3.6. Storage erase cycle

The 200 ms-off and 600 ms-on pulse generated by two circuits which are activated the moment the ERASE button is released.

- One circuit (TS 2101, 2102) which generates a 800 ms positive pulse at point 5 of IC 2102-B.
- The second circuit (TS 2112 and IC 2102-A) which generates a 200 ms zero pulse at point 12 of IC 2102-D.
- A third circuit (TS 2103 . . . 2105) which generates a 100 ms pulse in addition to the 800 ms pulse from TS 2102.

The steep trailing edge of this 900 ms pulse resets both the main time-base and the delayed time-base.

The +8 V of the positive pulses which is given in this text and pulse diagrams, is only an orientational value. In practise pulses up to +15 V may occur (depending on calibrations and c.r.t. properties).

d. Variable persistence

This mode can be seen as a continuous write/erase operation.
A square-wave signal is now applied to the memory-mesh, derived from the output of IC 2101-B.
The duty-cycle of this signal, adjustable with the PERSIST knob (R15) controls the persistence time.
During the higher positive (+8 V) voltage on the storage mesh, the flood-gun electrons will lower the local surface layer voltage (the positive charges are filled-up by the electrons). If the duty-cycle of the higher positive voltage is increased the persistence time will decrease.

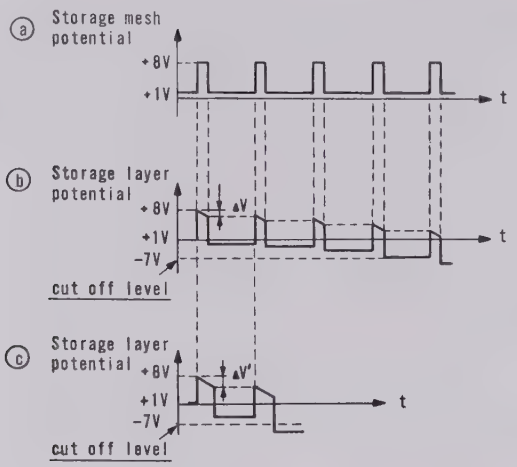


Fig. 3.7. Persistence mode

2. Beam current control*

In order to prevent damage of the cathode ray tube, due to too high dissipation of the electron beam on the memory mesh, an automatic beam current control circuit has been applied (TS 1322).
The blanking pulse, available at the emittor of TS 1328 is integrated by C1321/R1373.
The neg. side of C1321 is connected to the +6 V as fixed reference, via TS 1319 which is used as a switch.
TS 1319 is not conducting in positions:
– .5 s up to 10 ms incl. of the MTB sweep switch
– .2 s up to 10 ms incl. of the DTB sweep switch.
In this sweep-times no integration takes place, because this would include no equal brightness over the whole trace-length, however a certain negative feed-back control remains via the voltage divider R1373, 1374.

The integrated voltage across C1321 depends on:
– height of the Z-pulse (INTENS knob setting)
– duty-cycle of the Z-pulse (trigger, hold-off)

If the integrated voltage might increase, also the emitter voltage of TS 1322 increases which causes a higher current into the blanking amplifier input (TS 1323), resulting in decreasing beam circuit.
The average beam current (in the final anode circuit) is approx. 1 μA.

The +6 V reference for C1321 is taken from the base of TS 1323 in order to improve common mode suppression of the Z-amplifier.

In the EXT X DEFL mode the beam current control of not operative.

Modification beam current control circuit

(See Fig. 3.29.; TS 1319 detail for the old situation.

TS 1318 has been added, in order to obtain the same intensity ratio (m.t.b. sweep with intensified d.t.b.), in all time-base sweep speed positions.
In the old situation the intensity ratio at sweep speeds of 10 ms/div. and slower was remarkable lower (less brightness difference between intensified part and rest of the trace) then in the higher sweep speeds.
This is due to the fact that the integrated capacitor C1321 is switched-off in the slower sweep speed positions. Therefore an intensity ratio correction is then necessary.

TS 1318 draws current from the base-circuit of TS 1068 in the higher sweep speeds positions, which includes readjustment of R1115 (INTENS RATIO).

* *Formely known by the name: Automatic Brightness Control*

Required parts:

Transistor	TS 1318	BC 549C
Resistor	R1376	56,2 kohm MR25
Resistor	R1378	6,19 kohm MR25
Resistor	R1379	26,1 kohm MR25

From serial nr. D775 this modification is included in the instrument.

3. Dynamic focus control

The optimum focus setting of the c.r.t. is depending on the momentary c.r.t. electron beam current. As this current is also depending on the duty-cycle of the blanking pulse, the focus setting would be depending on the duty-cycle of the blanking pulse (trigger, hold-off, a.s.o.).
To compensate this, the d.c. focus voltage (g3 of the c.r.t.) is combined with a block voltage derived from the blanking pulse.

The blanking pulse available at the emittor of TS1328 is not only applied to the g1-circuit of the c.r.t., but also to the amplifier circuit TS1301 ... TS1303. This circuit inverts the signal and has a voltage gain of 1. The voltage at the emittor of TS1303 is applied to the focus circuit, via a d.c. path (TS1304) and an a.c. path (C1306), at the same way as in the intensity control circuit.

Both chopper circuits for the d.c. paths of the intensity- and the focus circuits have exactly the same frequency, obtained by the common, positive feed-back transistor TS1307.
In this way any frequency interference or zero-beat effect is suppressed.

4. Multiplier Fig. 3.21.

The signals on ch. A and ch. B can be multiplied.
The multiplied signal can be displayed (instead of ch. A) and taken-off from the output connector at the rear of the instrument.

The signals to be multiplied are taken from the intermediate amplifiers (points 4 and 5 of IC 302 of ch.A and 4 and 5 of IC 2302 of ch. B) and applied to the multiplier circuit.
The input circuits of the multiplier (IC 401, 402 for ch. A, and IC 2401, 2402 for ch. B) have a frequency compensation circuit for each channel. Also the 0 x A and 0 x B front panel adjustments take place in this circuits, for adjustment of the zero levels.
The ch. A and B signals are actually multiplied in IC 1901. Transistor TS 1901 controls the voltage levels in the multiplier circuit via the two diodes in IC 1901.
The output signal of IC 1901 is applied to IC 1902 by which the polarity of the multiplied signal can be inverted. If the ch. B signal is inverted (SK6), the ch. B signal to the multiplier is not inverted,
In this case also the multiplied signal must be inverted.

With preset potm. R1912 the zero levels for both normal- and inverted mode can be made equal. The scale factor (multiplier gain) is adjustable with R1931 which controls the resistance between points 4 and 5 of IC 1902, thus controlling the gain of the relative transistor-pair of IC 1902.
From the collectors of this transistor-pair the multiplied signal is fed to IC 1903, via TS 1903, 1904.

If SK1 (MULT) is depressed (contact 2-3 closed), TS 309 feeds current into IC 302, thus interrupting the normal ch. A signal path.
At the same time TS 1905 is cut-off (contact SK1 1-2 open), which allows the multiplied signal via IC 1903 to go back to the ch. A intermediate amplifier for further amplification.

From the emittors of the IC 1902 transistor-pair, also the multiplied signal is taken-off for the A x B output at the rear of the instrument. This signal is first amplified by a transistor-pair IC 2001 with frequency compensation circuit, and then via an output-stage TS 2002 . . . 2004 applied to the output connector.
The output signal is taken from the emitter-follower TS 2006, which is pre-loaded with TS 2004 for better common mode suppression.
TS 2001 regulates the A x B zero level with pot. meter R18 at the rear panel near the A x B output.
TS 2007 delivers an extra regulated supply voltage for the A x B output amplifier circuit.

The A x B output at the rear panel must be terminated with 50-ohms to obtain correct multiplication factor, and full bandwidth response.

Also, if the MULT. button is not depressed the multiplied signal is available at the A x B output connector.

3.4. CHECKING AND ADJUSTING

Introduction

This procedure describes how to check and adjust the following functions:
- Variable persistence/storage
- C.r.t. circuit
- Intermediate amplifier with multiplier

For the remaining subjects refer to the basic PM 3240 manual.

Before any adjustment or checking, the instrument must attain its normal operating temperature. Under average conditions this will be approximately 30 minutes after switching on.

All controls which are mentioned without item number are located on the front panel.

Use a viewing hood for better observation of the display.

Preliminary control settings

- Depress button A of the vertical display mode switch.
- Depress button MAIN TB of the horizontal display mode switch.
- Depress button AUTO of the trigger mode switch.
- MAIN TB sweep knob in position .1 ms/DIV.
- DEL'D TB sweep knob in position OFF.
- Both AMPL/DIV. knobs in position .1 V.
- All TIME/DIV. and AMPL/DIV. potmeters in CAL position.
- TB MAGN switch depressed (magnifier off).
- Set the POSITION controls to their mid-positions.
- Depress button AC of the A input coupling switch.
- Depress both buttons DC of the trigger-range selector switches.
- Depress button A of the MAIN TB source switch.
- Depress button MTB of the DEL'D TB trigger source switch.
- Knob HOLD OFF fully clockwise (shortest hold-off time).
- Depress both SAVE and READ buttons (MEMORY OFF).
- Operate the INTENS and FOCUS knobs to obtain a sharp trace of medium brightness.
- Set LEVEL controls for a stable display.
- When the instrument is in the WRITE mode, it is recommended to keep the PERSIST knob in the short-persistence position (fully counter clockwise).

  In this case the dynamic erase function is optimum.

1. Variable persistence/storage and writing speed

Introduction

- All adjustment controls are located on the persistence/storage unit.
- Remember to press the ERASE button in the WRITE mode after every (trial) adjustment.
- It is recommended first to check the adjustment of **R1329** (INT. MIN) on the Z-mod. unit, refer to **2***c*.
- The INTENS knob must be in the minimum position (fully counter clockwise) during the variable persistence/storage checking and adjusting procedure.
- Depress the WRITE button.
- No input signals.

a. Variable persistence/storage

Required instruments:
- Oscilloscope (5 MHz)
- Voltmeter

1. Memory mesh voltage (Adjustment only possible in older versions)
   - PERSIST control in position MAX. WRITE (fully clockwise)
   - The voltage on g9 must be +1 V with respect to earth.
     If necessary adjust **R2141** (VG 9)*
2. Collimator
   - PERSIST control in position minimum persistence (fully counter clockwise).
   - Check with **R2128** (V collim) that the green surface just overlaps the display surface of the c.r.t.

*R2142 was in series with R2140

Just no cushion-distortion; no rim-effects visible.
The collimator voltage will be between +55 V and +75 V.

3. Just black level.

Remind to press frequently the ERASE button.
– PERSIST control in position maximum persistence (not in MAX. WRITE).
– Adjust **R2168** (JUST BLACK) so that both "clouds" are visible and adjust **R2189** (BAL) so, that both "clouds" have same brightness.
After this, adjust **R2168** (JUST BLACK) so, that the display is just black. Use viewing hood.

4. Max. write

– PERSIST knob in position MAX. WRITE (press ERASE button).
Both "clouds" must be visible.
If necessary adjust **R2167** (INTENS. MAX. WRITE).

If necessary readjust **R2189** (BAL) for equal brightness of both "clouds". (The effect is clearly visible without operating the ERASE button).

If necessary adjust **R2131** (V COLLIM. MAX. WRITE), to obtain equal "cloud" distribution over the whole display surface.

Keep R2131 as fas as possible counter clockwise, otherwise the c.r.t.'s deflection sensitivity will decrease (press ERASE button).
If necessary adjust **R2124** (ΔV COLLIM) so, that the green surface just overlaps the display surface of the c.r.t. (equal background), especially in the corners and along the edge. No black centre.

If necessary repeat both points 3 and 4 for optimum results.

5. Save

– Depress button SAVE.
– The intensity of the display can be adjusted with **R2149** (SAVE).
– Apply the signal on G_2'-2" of the c.r.t. to an oscilloscope.
The duty cycle of the signal must be 10 % (for a save-time of 15 minutes).

6. Frequency

The frequency of the persist/storage control voltage depends on the position of **R2107** (FREQ.). Normally this pot. meter is in the mid-position.
Sometimes a ringing sound can be heard from the c.r.t. caused by resonance effects of the meshes. This can be suppressed by readjusting **R2107**.

b. Writing speed

Abstract from specification Writing speed.
Normal: 0,2 div/μs
Max. write: 2 div/μs

Required instrument:
– Sine-wave generator (2,5 kHz - 25 kHz, 1,6 V_{p-p})

1. Definition

The writing speed is the maximum speed of the electron beam in X- or Y-direction on the screen in single-shot mode in which the written line is visible.
The lines of the pictures obtained must be clearly visible in Normal, as well as in Max. write mode.
Some divisions at the rim of the screen may be partly or entirely not written (the written surface of the screen must be as symmetrical as possible).
The number of not-written divisions may not be more than 16, viz. 20 % of the whole screen surface (not more than 4 in each screen-corner).

2. Checking

The writing speed is checked as follows:
– Depress button A of the vertical deflection switch.
– Depress button WRITE.
– Depress button MAIN TB of the horizontal deflection switch.
– Apply a 2,5 kHz sine-wave signal to the A input.
– MTB sweep 1 ms/DIV.
– Set PERSIST knob to minimum persistence.
– Centre the trace.
– With the input attenuator adjust the amplitude of the input signal in such a way that a picture height of 32 divisions (peak-to-peak) is obtained.
(To this end first set the input attenuator to position .2 V/DIV and adjust the picture-height to 8 divisions by varying the input signal; then set the input attenuator to position 50 mV/div.).
– Trigger and focus the picture obtained.
– Depress SINGLE button of the main time-base trigger switch.
– Set PERSIST knob to position maximum persistence (not MAX. WRITE).
– INTENS knob maximum.
– Push ERASE button (this resets also the main time-base).
– If necessary repeat and adjust the focussing*) to maximum.

For checking in Max. write mode the operation is the same but:

– Set PERSIST knob to position MAX. WRITE.
– Frequency of the input signal 25 kHz.
– Set main time-base switch to .1 ms/div.

3. Calculation

The vertical deflection is 32 divisions as mentioned under 2 above.
The path described by the electron beam is then 16 div. $\sin\omega t$ (ω being the circle frequency of the input signal).
The speed of the beam in the vertical direction is thus $16\omega\cos\omega t$ (the speed in horizontal direction is negligible).
For the visible part of the sine-wave, $\cos\omega t = 1$ may be assumed.
The writing speed is now (in Norm. writing mode):
$16.2\ \pi.2,5.10^3$ div./s = $2,5.10^5$ div./s = 0,25 div./μs.

*) *In fact the electron beam should be focussed on the storage mesh layer to obtain optimum writing speed.*

2. C.r.t. circuit

Introduction

All adjustment controls are located on the Z mod unit.
– Depress the WRITE button.
– PERSIST knob to minimum persistence (fully counter clockwise).
– No input signals.

Required instrument:
– Oscilloscope (5 MHz).

a. Trace rotation

– Depress the A button of the vertical mode switch.
– Depress the AUTO button of the main time-base trigger mode.
– Adjust the TRACE ROTATION pot. meter (at the left-hand side of the cabinet) so, that the trace runs in parallel to the centre horizontal graticule line.

b. Astigmatism and Focus

Use an **insulated screwdriver**. High voltage on FOCUS preset-pot. meter !

– Apply a 6 divisions 10 kHz sine-wave signal to the A input.
– MAIN TB sweep knob to 50 µs/DIV.
– Set the INTENS knob to medium intensity.
– Set the FOCUS knob for best sharpness of the displayed waveform.

If the operating range of the FOCUS knob is not correct:
– Set the FOCUS knob in its mid-position.
– Adjust **R1338** (FOCUS) and **R1341** (ASTIG) for a sharp trace.

c. Minimum Intensity Write-gun (just black)

– WRITE button depressed.
– Set the horizontal POSITION control such, that the start point of the trace is visible on the screen.
– Depress the SINGLE button of the MTB trigger mode selector.
– PERSIST knob in MAX. WRITE position.
– INTENS knob to minimum intensity (press ERASE button).
– Adjust **R1329** (INT. MIN.) so that the spot is just not visible.
Check over a 10-seconds period at least. (after 1 or 2 minutes the spot may get visible).

d. Maximum Intensity (beam-current control)

– Connect an oscilloscope (10 V/DIV) to the testpoint on the Z-ampl. unit (near TS 1328).
– Depress the AUTO button of the mtb trigger mode switch.
– MTB sweep .1 ms/DIV.
– INTENS knob fully clockwise.
– PERSIST knob fully counter-clockwise.
– Depress the LINE button of the mtb trigger source selector.
The main time-base is now triggered by the line frequency (mains).

The pulse on the testpoint must now be 45 $V_{p\text{-}p}$ (on +12 V level).
If necessary adjust **R1386** (INT. MAX.).

– Depress the A button of the mtb trigger source selector.
The main time-base is now free running.

The pulse on the test point must now be 20...25 $V_{p\text{-}p}$ on the 12 V level.

e. Intensity Ratio

– Depress the AUTO button of the mtb trigger mode switch.
– MTB sweep 1 ms/DIV.
– DTB sweep .2 ms/DIV.
– Check that the intensified part of the trace can well be distinguished from the rest of the trace, in the control range of the INTENS knob.
If necessary adjust **R1115** (INTENS. RATIO).
The intensified part can be shifted with the DELAY TIME knob.

f. Z-pulse

- MTB sweep .05 µs/DIV.
- DTB sweep in position OFF.
- Adjust horizontal POSITION knob so, that the start point of the trace is visible on the screen.
- The starting section of the trace must have same intensity as the rest of the trace (no intensity - under - or over-shoot).
  If necessary adjust trimmer **C1338** (Z-HF).
  Check at various positions of the INTENS knob.

g. Barrel and cushion distortion

- Depress the A button of the vertical display mode switch.
- Depress the EXT X DEFL button of the horizontal display mode switch.
- Depress the B button of the TRIG or X DEFL switch of the main time-base.
- Depress both AC buttons of the input coupling switches.
- Apply a 100 kHz 8-div. sine-wave signal to A input.
- Apply a 50 Hz 10-div. sine-wave signal to the B input.
- Adjust both input attenuators to obtain a deflection of 7,4 x 9,4 divisions.
- The displayed rectangle must fit between the lines in indicated in Fig. 3.8.
  If necessary adjust **R1344** (GEOM.).

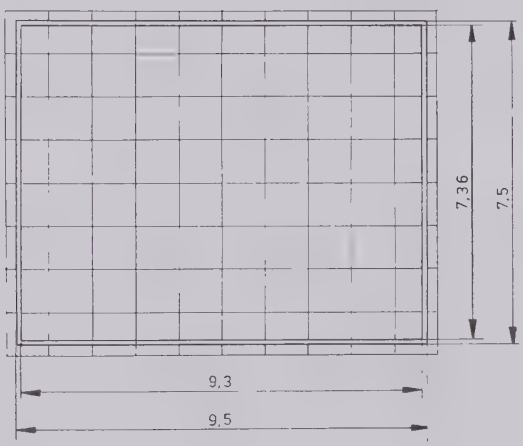


Fig. 3.8. Barrel and cushion distortion

MA 9558

- Depress the 0 button of the A input coupling switch.
- Check whether the trace runs over the horizontal centre graticule line.
  If necessary adjust **R18** (TRACE ROTATION) and/or **R1359** (ORT).
- Depress the AC button of the A input coupling switch.
- Depress the 0 button of the B input coupling switch.
- Check whether the trace runs over the vertical centre graticule line.
  If necessary readjust **R18**(TRACE ROTATION).

  Repeat if necessary.

h. R1390 (BEAM LIMIT). Only in older versions.

This pot. meter must be adjusted to 750 Ohm.

3. Input attenuator

Introduction

It is preferred to use the c.r.t. display in the MEMORY OFF mode (both SAVE and READ buttons depressed) for best observation of the display.

a. D.C. balance

No input signals.

1. 0-DC balance

   – Step attenuator switch to 20 mV/DIV
   – Depress alternately the 0 and DC buttons of the input coupling switch.

   The trace may not jump (max. 0,1 DIV).
   If necessary adjust **R129**

2. Step attenuator balance

   – Rotate the step attenuator between the 5 mV and 20 mV/DIV positions.

   The trace may not jump (max. 0,1 DIV).
   If necessary adjust **R12** BAL.

3. Variable gain balance

   – Step attenuator switch to 5 mV/DIV,
   – Rotate the variable gain knob.

   The trace may not shift (max. 0,1 DIV).
   If necessary adjust **R141** (DC OFFSET COMP).

b. A.C. compensation

Required instrument:
– Square-wave generator 120 $mV_{p\text{-}p}$.

1. 100 Hz square-wave compensation

   – Input signal 100 Hz square-wave .
   – Step attenuator switch to 20 mV/DIV.
   – Adjust input voltage to obtain 6 div's vertical deflection.
   – Main time-base sweep switch to 5 ms/DIV.

   The pulse distortion must be as low as possible (2 % max.).
   If necessary adjust **R132** (L.F. GAIN).

2. 25 kHz square-wave compensation.

   – Input signal 25 kHz square-wave .
   – Step attenuator switch to 20 mV/DIV.
   – Adjust input voltage to obtain 6 div's vertical deflection.
   – Main time-base sweep 10 μs/DIV.
   – The pulse distortion must be as low as possible (2 % max.).
   If necessary adjust **C122.**

3. For adjustment of input capacity and capacitive input attenuation refer to basic PM 3240 manual.

4. Intermediate amplifier and multiplier

Introduction

It is preferred to use the c.r.t. display in the MEMORY OFF mode (both SAVE and READ buttons depressed) for best observation of the display.

Note that during the checking of the multiplier circuits the OXA and OXB settings must be set for optimum zero-product compensation. Exact adjustment of the multiplier balance OXA and OXB settings is possible after adjustment of **R338** (see point a).

a. D.C. balance

Required instruments:
– 1 V regulated d.c. voltage source.
– Sine-wave generator 1 kHz.

1. Multiplier zero balance

   – Depress both MULT and B button of the vertical mode switch.
   – Depress the 0 button of the A input coupling switch.
   – Depress B input coupling AC switch.
   – Apply a 1 kHz sine-wave signal to input B.
   Set input attenuator B and the input voltage such that 6 $DIV_{p\text{-}p}$ B deflection is obtained.
   – Check that the zero product compensation lies symmetrically around the centre of the OXB control.
   If necessary adjust **R338** (+/–).

2. Multiplier balance OXA, OXB

   The OXA and OXB controls are operated by pushing the POSITION knobs.

   – Apply a 1 kHz sine-wave signal to both inputs A and B.
   – Set both attenuators for a deflection of 6 divisions.
   – Depress pushbutton MULT of the display-mode controls.
   – Depress pushbutton 0 of the channel A signal coupling controls.
   – Depress pushbutton AC of the channel B signal coupling controls.
   – Minimize the deflection by means of the OXB potentiometer without changing the attenuator setting.
   – Depress pushbutton AC of the channel A signal coupling controls.
   – Depress pushbutton 0 of the channel B signal coupling controls.
   – Minimize the deflection by means of the OXA potentiometer without changing the attenuator setting.

3. NORM/INVERT channel B.

   – Depress the B button of the vertical display mode switch.
   – Depress the 0 button of the B input coupling switch.
   – Check that the trace on the display does not jump when the NORM/INVERT switch is operated.
   If necessary adjust pot. meter **R2338** (+/–).

4. NORM/INVERT multiplier product.

   If channel B is inverted also the product is inverted; here is how to adjust this product-norm/invert balance.

   – Depress the 0 buttons of both input coupling switches.
   – Check that the product-trace does not jump when the NORM/INVERT switch is operated.
   If necessary adjust **R1912** (+/–).

5. Multiplier balance

   If both Y channels input voltages are zero, also the multiplier product must be zero.

   – Depress the 0 buttons of both input coupling switches.
   – Depress alternating the A and the MULT button of the vertical display mode switch.
   – Check the trace (A/MULT) does not jump.
   If necessary adjust **R1946** (BAL MULT).
   – Check the signal at the A x B output of the rear.
   If necessary adjust the A x B BAL control.

6. Multiplier gain (scale factor)

   – Depress the ALT button of the vertical display mode switch.
   – Depress the DC button of the A input coupling switch.
   – Apply the 1 V d.c. voltage to the A input.
   – Set the A input attenuator to obtain a deflection of 1 division.
   – Depress the AC button of the B input coupling switch.
   – Apply a 1 kHz sine-wave signal to the B input
   – Set the B input attenuator to obtain a deflection of 6 divisions.
   – Depress the MULT button of the vertical mode switch.
   – The multiplied signal must also show 6 divisions.
   If necessary adjust **R1931** (GAIN).

7. For adjustment of TRIG potmeters R362 and R2362 refer to basic PM 3240 manual.

b. H.F. compensation

General.

The intermediate amplifier of the –/03 version is different from the 01/ and /02 versions. At the /01 and /02 intermediate amplifier the h.f. compensation circuits are located on small p.c. boards; see Fig. 3.22 In the –/03 version the h.f. compensation circuits have been incorporated on the p.c. board itself; see Fig. 3.23.
First check whether the cause of an eventual signal distortion in the multiplier function is located in the A multipl. path, the B multipl. path, or in the multiplier-circuit itself.

– The main time-base sweep knob must be set for best possible observation of the pulse response, during the various frequency settings of the input signal.
– Depress the AC buttons (except at 1 kHz signals) of both input coupling switches, in order to remain within the dynamic range specifications.
When the d.c. voltages are applied (multiplier response) depress the relevant D.C. button.

Required instruments:
– 1 V regulated d.c. voltage source
– Pulse generator, rise time ⩽ 1 ns, with matched cable and cable-end termination.

Set the pulse generator to 120 $mV_{p\text{-}p}$ output voltage.

1. Straight forward ch. A.

– Depress button A of the vertical display mode switch.
– Apply the hf test signal to the A input.
– Set the A attenuator for 6 divisions deflection.
– Check the displayed signal.

If necessary, adjust or select following components depending on the frequency of the input signal.

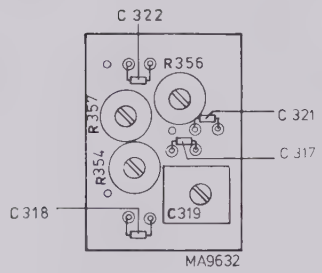


Fig. 3.9. H.F. compensation ch. A

Sequence	*Freq.*	*Item*	*Approx. value*
1	1 kHz	R354	–
		C318	4,7 nF
2	10 kHz	R357	–
		C322	820 pF
3	100 kHz	R356	–
		C319	–
		C321	27 pF
4	1 MHz	C317	0-10 pF

C302 can be adjusted at 100 kHz . . . 1 MHz.

2. Straight forward ch. B.

– Depress button B of the vertical mode switch.
– Apply the h.f. test signal to the B input.
– Set the B attenuator for 6 divisions delfection.
– Depress the NORM button of the B attenuator.
– Check the displayed signal.

If necessary, adjust or select following components depending on the frequency of the input signal.

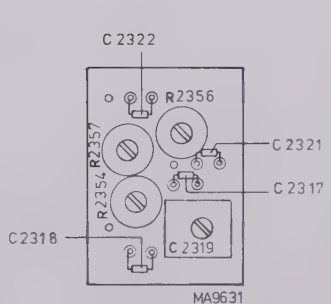


Fig. 3.10. H.F. compensation ch. B

Sequence	*Freq.*	*Item*	*Approx. value*
1	1 kHz	R2354	–
		C2318	4,7 nF
2	10 kHz	R2357	–
		C2322	820 pF
3	100 kHz	R2356	–
		C2319	–
		C2321	27 pF
4	1 MHz	C2317	0-10 pF

C2302 can be adjusted at 100 kHz - 1 MHz.

3. Straight-forward common A and B

   Knob settings and test signals as under 1 or 2.

   Check the displayed signal.

   If necessary, adjust or select following components, at 1 MHz.
   – C506 - (22 pF)
   – R514 - 4,99 ohm

4. A multiplier path

   – Depress button ALT of the vertical display mode switch.
   – Apply the h.f. test signal to the A input.
   – Set the A attenuator for 6 divisions deflection.
   – Apply the 1 V d.c. voltage to the B input.
   – Set the B attenuator for 1 div. deflection.
   – Depress the MULT button.
   – Check the h.f. response of the displayed multiplied signal (the signal must be 6 div.'s p-p).

   If necessary adjust or select following components depending on the frequency of the test signal.

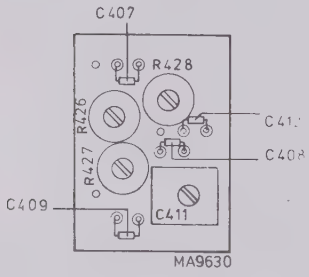


Fig. 3.11. H.F. compensation A MULT

Sequence	*Freq.*	*Item*	*Approx. value*
1	1 kHz	R427	–
		C409	10 nF
2	10 kHz	R426	–
		C407	4,7 nF
3	100 kHz	R428	–
		C411	–
		C412	15 . . .22 pF
4	1 MHz	C408	0 – 39 pF

Pulse-top flatness at 30 kHz can be adjusted with
– R447 –
– C414 1 nF

5. B multiplier path

   – Depress button ALT of the vertical display mode switch.
   – Apply the 1 V d.c. voltage to the A input.
   – Set the A attenuator for 1 div. deflection.
   – Apply the h.f. test signal to the B input.
   – Set the B attenuator for 6 div. deflection.
   – Depress the MULT button.
   – Check the h.f. response of the displayed multiplied signal (the signal must be 6 div.'s p-p).

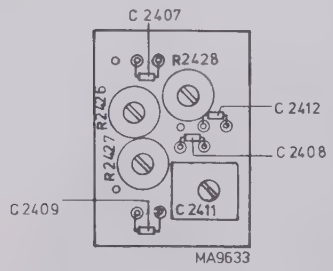


Fig. 3.12. H.F. compensation B MULT

Sequence	*Freq.*	*Item*	*Approx. value*
1	1 kHz	R2427	–
		C2409	10 nF
2	10 kHz	R2426	–
		C2407	4,7 nF
3	100 kHz	R2428	–
		C2411	–
		C2412	15...22 pF
4	1 MHz	C2408	33 pF

Pulse-top flatness at 30 kHz can be adjusted with
– R2447
– C2414 1 nF

6. Multiplier common

   Knob settings and test signals as under 4 or 5.

   – Check the displayed multiplied signal at a frequency of 1 MHz.

   If necessary adjust or select:
   – R1927
   – C1908 (22 pF)

7. Multiplier output h.f. response and gain.

   Knob settings and test signals as under 4 or 5.

   – Terminate the multiplier output at the rear panel with a 50 ohm termination.
   – Check the multiplier output voltage with a wide-band oscilloscope.
   Set this oscilloscope to 50 mV/div. in order to obtain the same 6 div.'s p-p display as on the oscilloscope under test.
   – If necessary adjust R2008, in order to obtain the exact output voltage.
   – If necessary adjust or select following components depending on the frequency of the test signal.

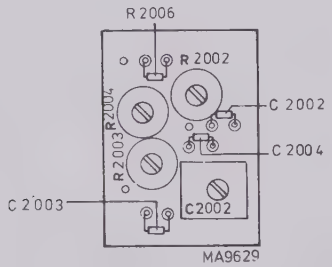


Fig. 3.13. H.F. compensation MULT. OUTPUT

Sequence	*Freq.*	*Item*	*Approx. value*
1	1 kHz	R2003	–
		C2003	10 nF
2	10 kHz	R2004	–
		C2006	(39 pF)
3*	100 kHz	R2002	–
		C2002	–
		C2001	22 – 39 pF
4*	1 MHz	C2004	56 –82 pF

*in combination with: – C2011

c. In some earlier PM 3243 models, the h.f. response compensation p.c. board were different from those drawn in this checking and adjusting procedure.

Fig. 3.14 shows the old model p.c. boards.
The sequence-numbers are identical.

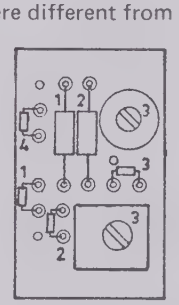


Fig. 3.14. H.F. compensation units, older models

d. Bandwidth check

Required instruments:

– Constant-amplitude sine-wave generator 50 kHz - 50 MHz
– 1 V regulated d.c. voltage source.

1. Straight-forward

   – Apply the sine-wave signal to the A-input.
   – A-input attenuator in position 0,1 V/div.
   – Adjust the signal amplitude in order to obtain 8 divisions deflection.
   Input frequency 50 kHz
   – Increase the frequency until the deflection is decreased to 5,6 divisions (–3 dB).
   – Repeat for the B channel.

2. Multiplier

   – Depress button ALT of the vertical display mode switch.
   – Apply the sine-wave signals to the A input, and set the A deflection as stated under 1.

– Apply the 1 V d.c. voltage to the B input.
  Set B deflection to 1 div.
– Depress button MULT.
– Increase the frequency until the deflection is decreased from 8 divisions to 5,6 divisions.
– Repeat with signals at inputs A and B interchanged.
– The multiplier output bandwidth can be checked similarly with a wide-band oscilloscope connected to the socket at the rear panel.
  The output must be terminated with 50 ohm.

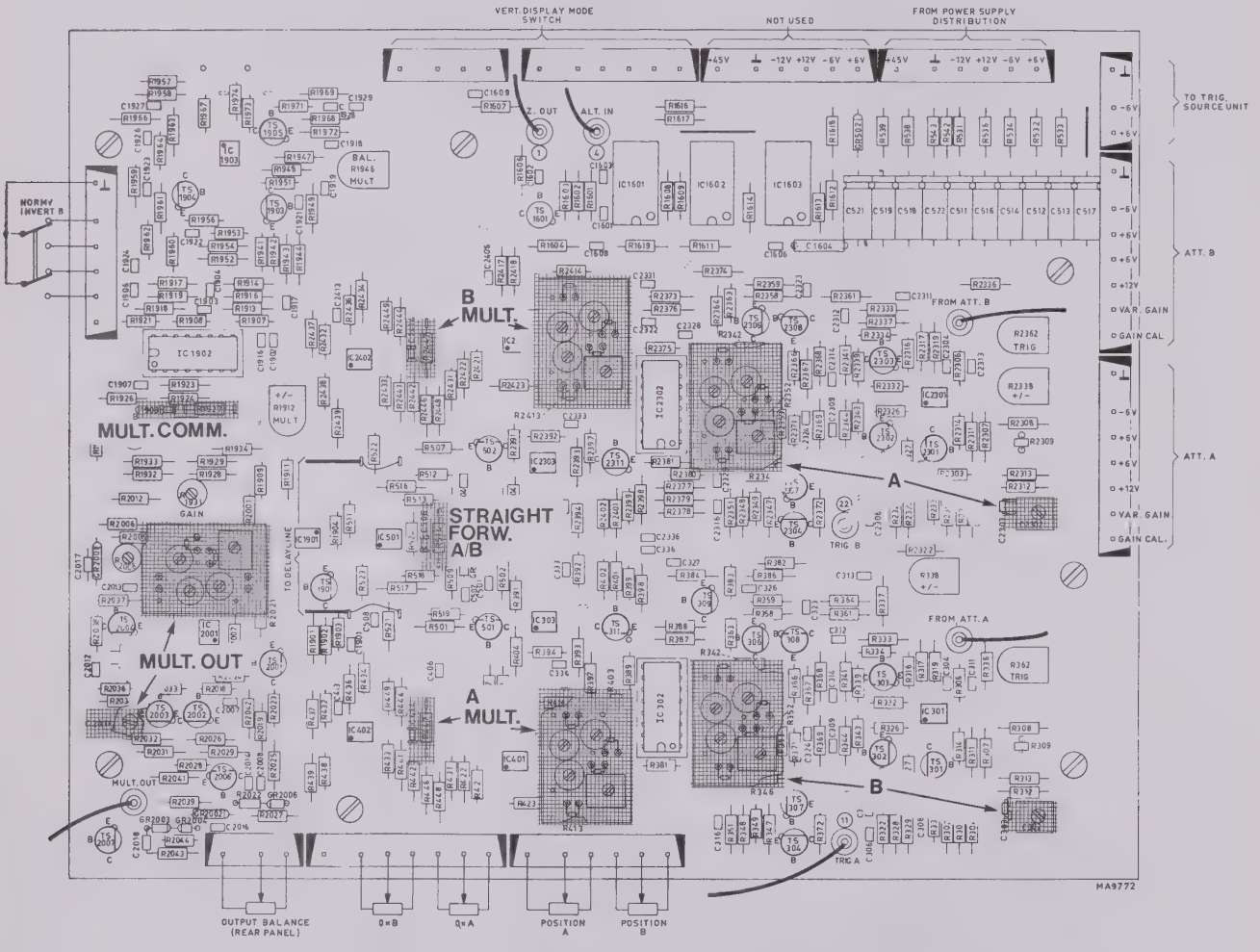


Fig. 3.14a. Location h.f. compensation circuits

3.5. PARTS LIST

MECHANICAL PARTS

For standard mechanical parts refer to the basic PM 3240 manual.

Complete units

Attenuator	5322 105 34044
Intermediate amplifier	5322 216 54159
Final Y-amplifier	5322 216 54161
Trigger source unit	5322 216 54163
Time-base with X-amplifier	5322 216 54157
Z-Amplifier	5322 216 54158
2 kV generator	5322 216 54156
High tension multipl. block	5322 218 64061
Var. pers./storage circuit	5322 216 54164
Auxiliary unit	5322 216 54162
Power supply unit	5322 216 54155

Various parts

Front side parts

–	5322 414 24911	Red push-button
–	5322 278 74007	Switch reset bar of push button switch assy's
–	5322 414 34136	Knob POSITION, 0 x BAL
–	5322 414 74019	Cover for this knob
–	5322 455 84061	Test strip in carrying handle
–	5322 455 84059	Text plate, front
–	5322 480 34046	Contrast filter, grey
–	5322 480 34074	Contrast filter, blue

Internal parts

–	5322 462 54133	Magnetic shield of c.r.t., top half
–	5322 462 54134	Magnetic shield of c.r.t., bottom half
–	5322 535 74525	Isolating shaft, 400 mm
–	5322 535 74526	Isolating shaft, 93 mm.
B1	5322 131 24041	Storage tube 89L14GH/55
T1802	5322 142 64064	Output transformer power supply unit

ELECTRICAL PARTS

TRANSISTORS

Type	*Stamp if SOT-23*	*Number in one instrument*	*Ordering code*	*Encapsulation*
BC547	–	6	5322 130 44257	TO-92 (2)
BC547C	–	2	5322 130 44503	TO-92 (2)
BC549	–	49	4822 130 40964	TO-92 (2)
BC549C	–	14	5322 130 44246	TO-92 (2)
BC557	–	6	5322 130 44256	TO-92 (2)
BC558	–	9	4822 130 40941	TO-92 (2)
BC559	–	21	4822 130 40963	TO-92 (2)
BCY71	–	2	5322 130 40373	TO-18
BD139	–	1	5322 130 40823	TO-126
BDY93/01	–	1	5322 130 44457	TO-3
BF199	–	6	5322 130 44154	TO-92(1)
BF324	–	17	5322 130 44396	TO-92(2)
BF336	–	2	4822 130 40908	TO-39
BF338	–	4	5322 130 44108	TO-39
BFR92R	P4	2	5322 130 44606	SOT-23
BFS17	E1	7	5322 130 40781	SOT-23
BFS17R	E4	6	5322 130 44338	SOT-23
BFT25R	V4	2	5322 130 44459	SOT-23
BFW44	–	4	5322 130 40672	TO-39
BFY90	–	9	5322 130 40493	TO-72(1)
BRY39	–	1	5322 130 40482	TO-72(3)
BSS38	–	4	4822 130 40968	TO-92(2)
BSW68	–	1	5322 130 40714	TO-39
BSX20	–	6	5322 130 40417	TO-18
BSX60	–	1	5322 130 44019	TO-39
BTX18/500	–	1	5322 130 24009	TO-39
CNY43	–	1	5322 130 44395	SOT-91B
FW5324	–	2	5322 130 40142	TO-72
FW5497	–	2	5322 130 40673	TO-72
ON471	M3	2	5322 130 44065	SOT-23
2N2894	–	2	5322 130 40018	TO-18
2N2894A	–	4	5322 130 44127	TO-18
537-BSY	B3	1	5322 130 44359	SOT-23
BU126	–	*	5322 130 44406	TO-3

*Selected pair in power supply unit.

DIODES

Type	*Number in one instrument*	*Ordering code*
Small signal and rectifier diodes		
AAZ15	2	5322 130 30229
AAZ17	2	5322 130 30283
AAZ18	1	5322 130 30084
BA182	3	5322 130 30644
BAV21	10	4822 130 30842
BAV45	2	5322 130 34037
BAW62	64	5322 130 30613
BAX12	2	5322 130 30424
BR100	1	4822 130 20039
BY206	23	4822 130 30839
BY409	1	5322 130 34594
BYX55/600	8	4822 130 30817
Voltage reference and stabistor diodes		
BZX61/C36	1	5322 130 30507
BZX61/C47	1	5322 130 30565
BZX61/C68	1	5322 130 30431
BZX61/C75	1	5322 130 34034
BZX75/C2V1	1	5322 130 34049
BZX75/C2V8	3	5322 130 34048
BZX79/B6V2	3	5322 130 34167
BZX79/B7V5	3	4822 130 30861
BZX79/B8V2	3	5322 130 34382
BZX79/B27	1	5322 130 34379
BZX79/B62	2	5322 130 34384
BZX79/C4V7	2	5322 130 30773
BZX79/C5V1	1	5322 130 30767
BZX79/C5V6	4	5322 130 34173
BZX79/C10	1	5322 130 34297
BZX79/C12	2	5322 130 34197
BZX79/C16	1	5322 130 34068
BZX79/C22	1	5322 130 30783
BZY88/C3V3	1	5322 130 30392
Light emitting diode		
CQY24A-1	2	5322 130 34595

INTEGRATED CIRCUITS

Type	*Number in one instrument*	*Ordering code*	*Encapsulation*
Digital circuits			
N7400	1	5322 209 84528	DIL14p
N7426	1	5322 209 84512	DIL14p
N7472	1	5322 209 84166	DIL14p
FZH181	1	5322 209 84379	DIL14p
Op. Amp. circuits			
LM208T	2	5322 209 85475	T
LM723CH	4	5322 209 84899	L
TCA220	1	5322 209 84386	DIL16p
709HC	1	5322 209 84452	T
Various			
OQ002	13	5322 209 84355	–
OQ006	1	5322 209 84356	–
OQ012	3	5322 209 85484	DIL14p
Resistor pad-IC102	2	5322 111 94032	–

CAPACITORS

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 101	5322 125 64009	3PF		500	TRIMMER
C 102	5322 125 64015	4,5PF		500	TRIMMER
C 103	5322 123 34001	30PF	10	300	MICA
C 104	4822 121 40278	22NF	10	400	POLYESTER FOIL
C 105	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 106	4822 122 31205	47PF	2	500	CERAMIC PLATE
C 107	5322 125 64012	1,5PF		400	TRIMMER
C 108	5322 125 64015	4,5PF		500	TRIMMER
C 109	5322 125 64009	3PF		500	TRIMMER
C 111	5322 125 64015	4,5PF		500	TRIMMER
C 112	5322 123 10168	300PF	10	300	MICA
C 113	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 114	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 116	4822 122 31173	220PF	2	500	CERAMIC PLATE
C 118	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 121	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 123	4822 122 30027	1NF	-20+80	40	CERAMIC PLATE
C 124	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 125	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 128	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 129	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 130	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 301	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 302	5322 125 50051	18PF		300	TRIMMER
C 303	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 304	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 306	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 307	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 308	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 309	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 311	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 312	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 313	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 314	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 316	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 317	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 318	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 319	5322 125 50051	18PF		300	TRIMMER
C 321	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 322	4822 122 30091	390PF	10	100	CERAMIC PLATE
C 323	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 324	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 326	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 327	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 333	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 334	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 336	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 406	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 407	4822 122 30048	1,8NF	10	100	CERAMIC PLATE
C 408	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 409	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 411	5322 125 50051	18PF		300	TRIMMER
C 412	4822 122 31069	39PF	2	100	CERAMIC PLATE
C 413	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 414	4822 122 30055	330PF	10	100	CERAMIC PLATE
C 501	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 503	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 504	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 506	4822 122 31067	33PF	2	100	CERAMIC PLATE
C 507	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 508	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 511	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 512	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 513	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 514	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 516	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 517	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 518	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 519	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 521	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 522	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 601	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 602	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 603	4822 125 50045	22PF		100	TRIMMER
C 604	4822 122 31074	56PF	2	100	CERAMIC PLATE
C 605	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 606	4822 125 50045	22PF		100	TRIMMER
C 607	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 608	4822 122 30027	1NF	10	100	CERAMIC PLATE
C 609	4822 122 31116	2,2NF	10	100	CERAMIC PLATE
C 614	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 616	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 618	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 619	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 621	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 622	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 623	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 624	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 626	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 627	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 628	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 629	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 631	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 632	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 633	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 634	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 651	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 652	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 653	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 701	4822 122 31198	18PF	2	500	CERAMIC PLATE
C 702	4822 121 40146	100NF	10	400	POLYESTER FOIL
C 703	4822 122 31202	33PF	2	500	CERAMIC PLATE
C 704	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 706	4822 122 31038	2,7PF	0,25PF	100	CERAMIC PLATE
C 707	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 708	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 709	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 751	4822 122 31198	18PF	2	500	CERAMIC PLATE
C 752	4822 121 40146	100NF	10	400	POLYESTER FOIL
C 753	4822 122 31202	33PF	2	500	CERAMIC PLATE
C 756	4822 122 31038	2,7PF	0,25PF	100	CERAMIC PLATE
C 757	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 758	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 759	4822 122 31177	470PF	10	100	CERAMIC PLATE
C 761	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 762	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 801	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 802	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 803	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 804	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 805	4822 122 31036	2,2PF	0,25PF	100	CERAMIC PLATE
C 806	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 807	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 808	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 809	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 850	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 851	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 852	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 853	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 854	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 855	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 856	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 857	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 858	4822 124 20483	6,8UF	-10+50	40	ELECTROLYTIC
C 859	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 800	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 801	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 802	4822 122 30114	2,2NF	10	100	CERAMIC PLATE
C 803	4822 124 20459	22UF	-10+50	10	ELECTROLYTIC
C 804	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 806	4822 121 50549	442PF	1	250	POLYSTYRENE FOIL
C 807	5322 121 40224	4,7UF	10	100	POLYESTER FOIL
C 808	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 809	5322 121 54108	47NF	1	63	POLYSTYRENE FOIL
C 871	5322 121 14072	330NF		35	BOX
C 872	4822 122 30034	470PF	10	100	CERAMIC PLATE
C 873	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 874	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 876	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 878	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 879	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 881	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 882	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1001	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1002	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1003	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1004	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1005	4822 122 31036	2,2PF	0,25PF	100	CERAMIC PLATE
C 1006	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1007	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1008	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1009	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1051	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1052	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1053	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1054	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 1056	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 1057	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1058	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 1059	4822 121 50549	442PF	1	250	POLYSTYRENE FOIL
C 1060	4822 122 31047	5,6PF	0,25PF	100	CERAMIC PLATE
C 1061	5322 121 54108	47NF	1	63	POLYSTYRENE FOIL
C 1062	4822 122 30034	470PF	10	100	CERAMIC PLATE
C 1063	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1064	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1065	5322 121 40224	4,7UF	10	100	POLYESTER FOIL
C 1066	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1067	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1068	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1069	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1201	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1202	4822 122 31034	1,8PF	0,25PF	100	CERAMIC PLATE
C 1203	4822 125 50077	5,5PF		100	TRIMMER
C 1204	4822 122 31116	2,2NF	10	500	CERAMIC PLATE
C 1205	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1206	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1207	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1208	4822 125 50077	5,5PF	10	250	TRIMMER
C 1209	4822 122 31034	1,8PF	0,25PF	100	CERAMIC PLATE
C 1211	4822 122 31116	2,2NF	10	500	CERAMIC PLATE
C 1212	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1213	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1214	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1216	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1301	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1302	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 1303	4822 122 30098	3,9NF	10	100	CERAMIC PLATE
C 1304	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1305	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 1306	4822 121 40253	1NF	10	1600	POLYESTER FOIL
C 1307	4822 121 40253	1NF	10	1600	POLYESTER FOIL
C 1308	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1309	5322 122 54006	3,3NF	-20+50	3K	CERAMIC DISK

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 1310	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1311	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 1312	4822 121 40411	33NF	10	250	POLYESTER FOIL
C 1313	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1314	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 1315	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 1316	4822 121 40357	3,3NF	10	1600	POLYESTER FOIL
C 1317	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 1319	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1321	4822 124 20452	33UF	-10+50	6,3	ELECTROLYTIC
C 1322	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1323	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1325	4822 122 30043	10NF	0	40	CERAMIC PLATE
C 1326	4822 124 20466	4,7UF	-10+50	16	ELECTROLYTIC
C 1327	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1328	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1329	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1331	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1332	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1333	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1334	4822 122 30114	2,2NF	10	100	CERAMIC PLATE
C 1338	5322 125 50048	3,5PF		300	TRIMMER
C 1339	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1341	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1342	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 1501	4822 124 20497	15UF	-10+50	63	ELECTROLYTIC
C 1502	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1503	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1504	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1506	5322 122 54006	3,3NF	-20+50	3K	CERAMIC DISK
C 1507	4822 121 40363	10NF	10	1600	POLYESTER FOIL
C 1517	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 1518	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 1519	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 1521	5322 122 54004	470PF	20	4K	CERAMIC DISK
C 1522	5322 122 24001	600PF	20	9K	CERAMIC TUBULAR
C 1601	4822 122 30027	1NF	10	100	CERAMIC PLATE
C 1602	4822 122 30094	220PF	10	100	CERAMIC PLATE
C 1603	4822 122 30053	680PF	10	100	CERAMIC PLATE
C 1604	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1606	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1608	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1609	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1621	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1622	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1623	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1624	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1626	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1627	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1642	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1643	4822 122 31081	100PF	2	100	CERAMIC PLATE
C 1644	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1646	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1647	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 1801	5322 121 44142	220NF	10	250	POLYESTER FOIL
C 1802	5322 122 44009	2,2NF	20	250	CERAMIC DISK
C 1803	5322 122 44009	2,2NF	20	250	CERAMIC DISK
C 1804	5322 121 44142	220NF	10	250	POLYESTER FOIL
C 1805	4822 121 40427	220NF	10	100	POLYESTER FOIL
C 1806	4822 124 40066	2x500F		400	ELECTROLYTIC
C 1807	4822 124 40066	2x50UF		400	ELECTROLYTIC
C 1808	4822 124 20462	100UF	-10+50	10	ELECTROLYTIC
C 1809	5322 124 24153	220UF		100	ELECTROLYTIC
C 1810	4822 124 20581	220UF	-10+50	4	ELECTROLYTIC
C 1811	4822 121 40239	47NF	10	100	POLYESTER FOIL
C 1812	4822 124 20581	220UF	-10+50	4	ELECTROLYTIC
C 1813	4822 122 31173	220PF	10	100	CERAMIC PLATE
C 1814	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 1615	4822 121 40208	1UF	10	250	POLYESTER FOIL
C 1816	4822 121 40104	150NF	10	250	POLYESTER FOIL
C 1817	4822 121 40452	1,5UF	10	100	POLYESTER FOIL
C 1818	4822 124 20483	6,8UF	-10+50	40	ELECTROLYTIC
C 1819	4822 121 41169	220NF	10	250	POLYESTER FOIL
C 1820	4822 122 31175	1NF	10	100	CERAMIC PLATE
C 1821	4822 121 40407	22NF	10	250	POLYESTER FOIL
C 1822	4822 121 41169	1,5UF	10	100	POLYESTER FOIL
C 1823	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1824	4822 124 20465	330UF	-10+50	10	ELECTROLYTIC
C 1825	5322 122 54006	3,3NF	-20+50	3K	CERAMIC DISK
C 1826	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1827	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1828	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1829	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1830	4822 121 40104	150NF	10	250	POLYESTER FOIL
C 1831	4822 124 20497	15UF	-10+50	63	ELECTROLYTIC
C 1832	4822 124 20497	15UF	-10+50	63	ELECTROLYTIC
C 1833	4822 124 20488	100UF	-10+50	40	ELECTROLYTIC
C 1834	4822 124 20485	33UF	-10+50	40	ELECTROLYTIC
C 1835	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 1836	4822 124 20488	100UF	-10+50	40	ELECTROLYTIC
C 1837	4822 124 20485	33UF	-10+50	40	ELECTROLYTIC
C 1838	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC
C 1839	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC
C 1840	4822 121 41161	100NF	10	250	POLYESTER FOIL
C 1841	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC
C 1842	4822 124 20469	68UF	-10+50	16	ELECTROLYTIC
C 1843	4822 124 20454	150UF	-10+50	6,3	ELECTROLYTIC
C 1844	4822 124 20454	150UF	-10+50	6,3	ELECTROLYTIC
C 1845	4822 121 40411	33NF	10	400	POLYESTER FOIL
C 1846	4822 124 20454	150UF	-10+50	6,3	ELECTROLYTIC
C 1847	4822 124 20454	150UF	-10+50	6,3	ELECTROLYTIC
C 1849	4822 122 31177	470PF	10	500	CERAMIC PLATE
C 1851	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 1881	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 1901	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1902	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1903	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1904	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1906	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1907	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1908	4822 122 31063	22PF	2	100	CERAMIC PLATE
C 1909	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1916	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 1917	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1918	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1919	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1921	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 1922	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1923	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1924	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 1926	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 1927	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1928	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 1929	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2002	5322 125 50051	18PF			TRIMMER
C 2007	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 2008	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2012	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 2013	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2014	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2016	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2101	5322 124 20377	68UF	-10+50	16	ELECTROLYTIC
C 2102	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 2103	4822 121 41134	10NF	10	250	POLYESTER FOIL
C 2104	5322 121 40197	1UF	10	100	POLYESTER FOIL
C 2105	4822 124 20466	4,7UF	-10+50	16	ELECTROLYTIC
C 2106	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE

ITEM	ORDERING NUMBER	FARAD	TOL (%)	VOLTS	REMARKS
C 2107	4822 121 40257	330NF	10	100	POLYESTER FOIL
C 2109	4822 121 41161	470PF	10	100	POLYESTER FOIL
C 2111	4822 122 31165	330PF	10	100	CERAMIC PLATE
C 2112	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 2113	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 2114	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 2116	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 2117	4822 121 40239	47NF	10	250	POLYESTER FOIL
C 2119	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2120	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2121	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2122	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2201	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 2202	5322 121 40233	680NF	10	100	POLYESTER FOIL
C 2203	4822 121 50611	20NF		63	POLYSTYRENE FOIL
C 2204	4822 124 20467	15UF	-10+50	16	ELECTROLYTIC
C 2206	4822 122 30103	22NF	-20+80	40	CERAMIC PLATE
C 2301	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2302	5322 125 50051	18PF		300	TRIMMER
C 2303	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 2304	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2306	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2307	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 2308	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2309	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2311	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2312	4822 122 31054	10PF	2	100	CERAMIC PLATE
C 2313	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2314	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2316	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2317	4822 122 31058	15PF	2	100	CERAMIC PLATE
C 2318	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 2319	5322 125 50051	18PF		300	TRIMMER
C 2321	4822 122 31061	18PF	2	100	CERAMIC PLATE
C 2322	4822 122 30091	390PF	10	100	CERAMIC PLATE
C 2323	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2324	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 2328	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2329	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2331	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2332	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2333	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2334	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2336	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2406	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2407	4822 122 30048	1,8NF	10	100	CERAMIC PLATE
C 2408	4822 122 30045	27PF	2	100	CERAMIC PLATE
C 2409	4822 122 30128	4,7NF	10	100	CERAMIC PLATE
C 2411	5322 125 50051	18PF		300	TRIMMER
C 2412	4822 122 31069	39PF	2	100	CERAMIC PLATE
C 2413	4822 122 30043	10NF	-20+80	40	CERAMIC PLATE
C 2414	4822 122 30055	330PF	10	100	CERAMIC PLATE

RESISTORS

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1	5322 103 64016	5K	5	2W	WIRE-WOUND POTENTIOMETER
R 2	5322 101 44015	50K	20	CP16	CARBON POTM LIN + SWITCH
R 3	5322 101 44026	2x500	20	0,3W	CARBON POTM LIN + SWITCH
R 5	5322 101 44026	2x500	20	0,3W	CARBON POTM LIN + SWITCH
R 7	5322 101 44014	100K	20	CP16	CARBON POTM LIN + SWITCH
R 8	5322 101 44014	100K	20	CP16	CARBON POTM LIN + SWITCH
R 9	5322 101 54006	10K	20	0,1W	CARBON POTM LOG + SWITCH
R 10	5322 101 40041	4,7K	20	0.25W	CARBON POTM LIN + SWITCH
R 11	5322 101 40041	4,7K	20	0.25W	CARBON POTM LIN + SWITCH
R 12	5322 101 24099	10K	20	0,1W	CARBON POTM LIN
R 13	5322 101 34016	47K	20	0,1W	CARBON POTM LOG
R 14	5322 101 24055	25K	20	CP16	CARBON POTM LIN
R 15	5322 101 44027	10K	20	0,1W	CARBON POTM LIN + SWITCH
R 16	5322 101 24113	1M	20	0,1W	CARBON POTM LIN
R 17	5322 101 24112	47K	20	0,1W	CARBON POTM LIN
R 18	4822 101 20455	1K	20	0,1W	CARBON POTM LIN
R 101	5322 116 64048	56	5	0,125W	METAL OXIDE
R 102	5322 116 55021	920K	0,25	MR30	METAL FILM
R 103	5322 116 64052	39	5	0,125W	METAL OXIDE
R 104	5322 116 55067	88,9K	0,25	MR24C	METAL FILM
R 106	5322 116 64046	51	5	0,125W	METAL OXIDE
R 107	5322 116 54892	200K	0,25	MR25	METAL FILM
R 108	5322 116 64045	10	5	0,125W	METAL OXIDE
R 109	5322 116 64047	560	5	0,125W	METAL OXIDE
R 111	5322 116 64047	560	5	0,125W	METAL OXIDE
R 112	5322 116 64048	56	5	0,125W	METAL OXIDE
R 113	5322 116 55022	992K	0,25	MR30	METAL FILM
R 114	5322 116 64049	47	5	0,125W	METAL OXIDE
R 116	5322 116 55066	8,08K	0,25	MR24C	METAL FILM
R 117	5322 116 64051	15	5	0,125W	METAL OXIDE
R 118	5322 116 64051	15	5	0,125W	METAL OXIDE
R 119	5322 111 30376	100M	5	0,125W	CARBON
R 121	5322 116 50484	4,64K	1	MR25	METAL FILM
R 122	5322 116 54012	6,81K	1	MR25	METAL FILM
R 123	5322 116 54519	402	1	MR25	METAL FILM
R 124	5322 116 54208	210K	1	MR25	METAL FILM
R 126	5322 116 54774	590K	1	MR30	METAL FILM
R 127	5322 116 54038	221K	1	MR25	METAL FILM
R 128	4822 110 42214	10M	5	VR37	CARBON
R 129	5322 100 10143	1K	20	0,75W	TRIMMING POTM
R 131	5322 116 54208	210K	1	MR25	METAL FILM
R 132	5322 100 10141	10K	20	0,75W	TRIMMING POTM
R 133	5322 116 54689	82,5K	1	MR25	METAL FILM
R 134	4822 110 42227	33M	5	VR37	CARBON
R 139	5322 116 50672	51,1K	1	MR25	METAL FILM
R 141	5322 100 10141	10K	20	0,75W	TRIMMING POTM
R 148	5322 116 50592	442	1	MR25	METAL FILM
R 149	5322 116 50592	442	1	MR25	METAL FILM
R 301	5322 116 50524	3,01K	1	MR25	METAL FILM
R 302	5322 116 54508	301	1	MR25	METAL FILM
R 303	4822 111 30067	33	5	CR16	CARBON
R 304	5322 116 50524	3,01K	1	MR25	METAL FILM
R 306	4822 111 30347	10	5	CR16	CARBON
R 307	5322 116 50492	46,4	1	MR25	METAL FILM
R 308	5322 116 54464	86,6	1	MR25	METAL FILM
R 309	5322 116 34036	47	5	0,5W	NTC
R 311	5322 116 50492	46,4	1	MR25	METAL FILM
R 312	5322 116 50568	4,99	1	MR25	METAL FILM
R 313	5322 116 54464	86,6	1	MR25	METAL FILM
R 314	4822 111 30347	10	5	CR16	CARBON
R 316	4822 111 30067	33	5	CR16	CARBON
R 317	5322 116 50515	1,78K	1	MR25	METAL FILM
R 319	5322 116 54005	3,32K	1	MR25	METAL FILM
R 322	5322 116 50452	10	1	MR25	METAL FILM
R 323	5322 116 50571	715	1	MR25	METAL FILM
R 324	4822 111 30245	47	5	CR16	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 326	4822 111 30067	33	5	CR16	CARBON
R 327	4822 111 30067	33	5	CR16	CARBON
R 328	5322 116 54576	2,37K	1	MR25	METAL FILM
R 329	5322 116 54587	3,65K	1	MR25	METAL FILM
R 331	4822 111 30067	33	5	CR16	CARBON
R 332	4822 111 30067	33	5	CR16	CARBON
R 333	5322 116 50571	715	1	MR25	METAL FILM
R 334	4822 111 30245	47	5	CR16	CARBON
R 336	5322 116 50452	10	1	MR25	METAL FILM
R 337	5322 116 50442	48,7K	1	MR25	METAL FILM
R 338	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 339	4822 111 30067	33	5	CR16	CARBON
R 341	5322 116 54492	178	1	MR25	METAL FILM
R 342	4822 110 63067	33	5	CR25	CARBON
R 343	4822 111 30067	33	5	CR16	CARBON
R 344	5322 116 54492	178	1	MR25	METAL FILM
R 346	4822 110 63067	33	5	CR25	CARBON
R 347	5322 116 54515	348	1	MR25	METAL FILM
R 348	5322 116 54005	3,32K	1	MR25	METAL FILM
R 349	4822 111 30067	33	5	CR16	CARBON
R 351	5322 116 54613	8,66K	1	MR25	METAL FILM
R 352	5322 116 50926	40,2	1	MR25	METAL FILM
R 353	5322 116 50926	40,2	1	MR25	METAL FILM
R 354	5322 116 50556	4,42K	1	MR25	METAL FILM
R 356	5322 100 10143	1K	20	0,75W	TRIMMING POTM
R 357	5322 116 54589	3,83K	1	MR25	METAL FILM
R 358	5322 116 54519	402	1	MR25	METAL FILM
R 359	5322 116 54012	6,81K	1	MR25	METAL FILM
R 361	5322 116 50483	38,3K	1	MR25	METAL FILM
R 362	5322 101 14048	47K	20	0,5W	TRIMMING POTM
R 363	4822 111 30067	33	5	CR16	CARBON
R 364	5322 116 50481	22,6K	1	MR25	METAL FILM
R 366	4822 111 30324	100	5	CR16	CARBON
R 367	5322 116 50452	10	1	MR25	METAL FILM
R 368	5322 116 50926	40,2	1	MR25	METAL FILM
R 369	5322 116 50926	40,2	1	MR25	METAL FILM
R 371	4822 111 30324	100	5	CR16	CARBON
R 372	5322 116 50527	33,2	1	MR25	METAL FILM
R 381	4822 111 30067	33	5	CR16	CARBON
R 382	5322 116 54513	332	1	MR25	METAL FILM
R 383	4822 111 30067	33	5	CR16	CARBON
R 384	5322 116 50555	1,27K	1	MR25	METAL FILM
R 386	5322 116 54592	4,02K	1	MR25	METAL FILM
R 387	5322 116 50515	1,78K	1	MR25	METAL FILM
R 388	5322 116 50581	2,49K	1	MR25	METAL FILM
R 389	4822 111 30067	33	5	CR16	CARBON
R 391	4822 111 30067	33	5	CR16	CARBON
R 392	4822 111 30067	33	5	CR16	CARBON
R 393	5322 116 54469	100	1	MR25	METAL FILM
R 394	4822 111 30067	33	5	CR16	CARBON
R 397	5322 116 54469	100	1	MR25	METAL FILM
R 398	5322 116 50621	536	1	MR25	METAL FILM
R 399	4822 111 30067	33	5	CR16	CARBON
R 401	5322 116 50524	3,01K	1	MR25	METAL FILM
R 402	5322 116 54613	8,66K	1	MR25	METAL FILM
R 403	4822 111 30067	33	5	CR16	CARBON
R 404	5322 116 54469	100	1	MR25	METAL FILM
R 413	4822 111 30324	100	5	CR16	CARBON
R 414	4822 111 30324	100	5	CR16	CARBON
R 416	4822 111 30067	33	5	CR16	CARBON
R 417	5322 116 54536	750	1	MR25	METAL FILM
R 418	5322 116 54536	750	1	MR25	METAL FILM
R 419	5322 116 54005	3,32K	1	MR25	METAL FILM
R 421	4822 111 30067	33	5	CR16	CARBON
R 422	5322 116 54608	7,5K	1	MR25	METAL FILM
R 423	5322 116 50492	46,4	1	MR25	METAL FILM
R 424	5322 116 50492	46,4	1	MR25	METAL FILM
R 426	5322 116 50675	2,26K	1	MR25	METAL FILM
R 428	5322 100 10143	1K	20	0,75W	TRIMMING POTM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 429	5322 116 50676	196	1	MR25	METAL FILM
R 431	5322 116 50676	196	1	MR25	METAL FILM
R 432	4822 111 30067	33	5	CR16	CARBON
R 433	4822 111 30067	33	5	CR16	CARBON
R 434	5322 116 54536	750	1	MR25	METAL FILM
R 436	5322 116 54536	750	1	MR25	METAL FILM
R 437	5322 116 54005	3,32K	1	MR25	METAL FILM
R 438	4822 111 30067	33	5	CR16	CARBON
R 439	5322 116 54608	7,5K	1	MR25	METAL FILM
R 441	5322 116 54561	1,33K	1	MR25	METAL FILM
R 442	5322 116 54504	274	1	MR25	METAL FILM
R 444	5322 116 54462	82,5	1	MR25	METAL FILM
R 446	5322 116 54504	274	1	MR25	METAL FILM
R 447	5322 116 50581	2,49K	1	MR25	METAL FILM
R 448	5322 116 54561	1,33K	1	MR25	METAL FILM
R 449	4822 111 30067	33	5	CR16	CARBON
R 501	5322 116 54442	51,1	1	MR25	METAL FILM
R 502	5322 116 54502	261	1	MR25	METAL FILM
R 503	5322 116 50452	10	1	MR25	METAL FILM
R 504	5322 116 50925	15,4	1	MR25	METAL FILM
R 506	5322 116 54502	261	1	MR25	METAL FILM
R 507	5322 116 54442	51,1	1	MR25	METAL FILM
R 508	5322 116 54492	178	1	MR25	METAL FILM
R 509	5322 116 54492	178	1	MR25	METAL FILM
R 511	4822 111 30067	33	5	CR16	CARBON
R 512	4822 111 30245	47	5	CR16	CARBON
R 513	4822 111 30067	33	5	CR16	CARBON
R 514	5322 116 50568	4,99	1	MR25	METAL FILM
R 516	5322 116 51052	42,2	1	MR25	METAL FILM
R 517	5322 116 51052	42,2	1	MR25	METAL FILM
R 518	4822 111 30067	33	5	CR16	CARBON
R 519	4822 111 30245	47	5	CR16	CARBON
R 521	5322 116 54561	1,33K	1	MR25	METAL FILM
R 522	5322 116 54561	1,33K	1	MR25	METAL FILM
R 523	4822 111 30067	33	5	CR16	CARBON
R 524	5322 116 54469	100	1	MR25	METAL FILM
R 531	5322 116 54128	5,62	1	MR25	METAL FILM
R 532	5322 116 50568	4,99	1	MR25	METAL FILM
R 533	5322 116 54258	9,53	1	MR25	METAL FILM
R 534	5322 116 50568	4,99	1	MR25	METAL FILM
R 536	5322 116 54258	9,53	1	MR25	METAL FILM
R 538	5322 116 54258	9,53	1	MR25	METAL FILM
R 539	5322 116 54258	9,53	1	MR25	METAL FILM
R 541	5322 116 54431	16,2	1	MR25	METAL FILM
R 542	5322 116 51051	8,66	1	MR25	METAL FILM
R 543	5322 116 51051	8,66	1	MR25	METAL FILM
R 601	5322 116 50926	40,2	1	MR25	METAL FILM
R 602	5322 116 54506	287	1	MR25	METAL FILM
R 603	4822 111 30067	33	5	CR16	CARBON
R 604	5322 116 54492	178	1	MR25	METAL FILM
R 606	5322 116 50676	196	1	MR25	METAL FILM
R 607	5322 116 54519	402	1	MR25	METAL FILM
R 608	4822 111 30067	33	5	CR16	CARBON
R 609	5322 116 54492	178	1	MR25	METAL FILM
R 610	5322 116 50524	3,01K	1	MR25	METAL FILM
R 611	5322 116 50926	40,2	1	MR25	METAL FILM
R 612	5322 116 54506	287	1	MR25	METAL FILM
R 613	5322 116 50506	154	1	MR25	METAL FILM
R 614	4822 111 30067	33	5	CR16	CARBON
R 615	5322 116 50524	3,01K	1	MR25	METAL FILM
R 616	5322 116 54444	53,6	1	MR25	METAL FILM
R 617	4822 111 30067	33	5	CR16	CARBON
R 618	5322 116 54444	53,6	1	MR25	METAL FILM
R 619	5322 101 14011	100	20	0,5W	TRIMMING POTM
R 621	5322 100 10114	4,7K	20	0,5W	TRIMMING POTM
R 622	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 623	5322 116 54613	8,66K	1	MR25	METAL FILM
R 624	5322 116 54619	10K	1	MR25	METAL FILM
R 627	4822 111 30245	47	5	CR16	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 628	4822 111 30067	33	5	CR16	CARBON
R 629	5322 116 54608	7,5K	1	MR25	METAL FILM
R 630	4822 111 30067	33	5	CR16	CARBON
R 631	5322 116 50556	4,42K	1	MR25	METAL FILM
R 632	4822 111 30245	47	5	CR16	CARBON
R 633	4822 111 30067	33	5	CR16	CARBON
R 634	4822 111 30067	33	5	CR16	CARBON
R 636	4822 111 30067	33	5	CR16	CARBON
R 637	5322 116 50457	215	1	MR25	METAL FILM
R 638	5322 116 50669	205	1	MR25	METAL FILM
R 639	5322 116 54451	61,9	1	MR25	METAL FILM
R 641	5322 101 14047	470	20	0,5W	TRIMMING POTM
R 642	5322 116 50457	215	1	MR25	METAL FILM
R 644	5322 116 50669	205	1	MR25	METAL FILM
R 646	5322 116 54451	61,9	1	MR25	METAL FILM
R 647	4822 111 30067	33	5	CR16	CARBON
R 648	4822 111 30245	47	5	CR16	CARBON
R 649	5322 116 50515	1,78K	1	MR25	METAL FILM
R 650	5322 116 54615	9,09K	1	MR25	METAL FILM
R 651	5322 116 54585	3,48K	1	MR25	METAL FILM
R 652	5322 116 50474	42,2K	1	MR25	METAL FILM
R 653	5322 116 50417	162	1	MR25	METAL FILM
R 654	5322 116 54011	5,62K	1	MR25	METAL FILM
R 655	5322 116 50904	30,1	1	MR25	METAL FILM
R 656	5322 116 54557	1,21K	1	MR25	METAL FILM
R 657	5322 116 50579	3,16K	1	MR25	METAL FILM
R 658	5322 116 54516	365	1	MR25	METAL FILM
R 659	4822 111 30067	33	5	CR16	CARBON
R 660	5322 116 54516	365	1	MR25	METAL FILM
R 661	5322 116 50509	4,87K	1	MR25	METAL FILM
R 662	5322 116 50579	3,16K	1	MR25	METAL FILM
R 663	5322 116 54012	6,81K	1	MR25	METAL FILM
R 664	5322 116 54557	1,21K	1	MR25	METAL FILM
R 665	5322 116 54615	9,09K	1	MR25	METAL FILM
R 666	5322 116 54011	5,62K	1	MR25	METAL FILM
R 667	4822 111 30245	47	5	CR16	CARBON
R 668	5322 116 50515	1,78K	1	MR25	METAL FILM
R 669	5322 116 54585	3,48K	1	MR25	METAL FILM
R 671	5322 116 50474	42,2K	1	MR25	METAL FILM
R 672	5322 116 50417	162	1	MR25	METAL FILM
R 681	5322 116 50568	4,99	1	MR25	METAL FILM
R 682	5322 116 50568	4,99	1	MR25	METAL FILM
R 683	5322 116 50568	4,99	1	MR25	METAL FILM
R 684	5322 101 20408	100K	20	0,1W	CARBON POTM LIN
R 700	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 701	5322 116 50527	33,2	1	MR25	METAL FILM
R 702	5322 116 54263	681K	1	MR30	METAL FILM
R 703	5322 116 54549	1K	1	MR25	METAL FILM
R 704	5322 116 54549	1K	1	MR25	METAL FILM
R 705	5322 116 54595	5,11K	1	MR25	METAL FILM
R 706	5322 116 54743	301K	1	MR25	METAL FILM
R 707	5322 116 50527	33,2	1	MR25	METAL FILM
R 708	5322 116 50527	33,2	1	MR25	METAL FILM
R 709	5322 116 50527	33,2	1	MR25	METAL FILM
R 710	5322 116 54038	221K	1	MR25	METAL FILM
R 711	5322 116 50491	22,6	1	MR25	METAL FILM
R 712	5322 116 54619	10K	1	MR25	METAL FILM
R 713	5322 116 54624	11,5K	1	MR25	METAL FILM
R 714	5322 116 50527	33,2	1	MR25	METAL FILM
R 716	5322 116 50664	2,05K	1	MR25	METAL FILM
R 717	5322 116 54549	1K	1	MR25	METAL FILM
R 718	5322 116 54545	909	1	MR25	METAL FILM
R 719	5322 116 50527	33,2	1	MR25	METAL FILM
R 721	5322 116 50555	1,27K	1	MR25	METAL FILM
R 722	5322 116 54525	511	1	MR25	METAL FILM
R 723	5322 116 50527	33,2	1	MR25	METAL FILM
R 724	5322 116 50527	33,2	1	MR25	METAL FILM
R 726	5322 116 54549	1K	1	MR25	METAL FILM
R 727	5322 116 50527	33,2	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 728	5322 116 54469	100	1	MR25	METAL FILM
R 729	5322 116 50731	10,5K	1	MR25	METAL FILM
R 731	5322 116 50527	33,2	1	MR25	METAL FILM
R 732	5322 116 50527	33,2	1	MR25	METAL FILM
R 733	5322 116 50527	33,2	1	MR25	METAL FILM
R 734	5322 116 50731	10,5K	1	MR25	METAL FILM
R 751	5322 116 50527	33,2	1	MR25	METAL FILM
R 752	5322 116 54263	681K	1	MR30	METAL FILM
R 753	5322 116 54549	1K	1	MR25	METAL FILM
R 754	5322 116 54549	1K	1	MR25	METAL FILM
R 756	5322 116 54743	301K	1	MR25	METAL FILM
R 757	5322 116 50527	33,2	1	MR25	METAL FILM
R 758	5322 116 50527	33,2	1	MR25	METAL FILM
R 759	5322 116 50527	33,2	1	MR25	METAL FILM
R 760	5322 116 54038	221K	1	MR25	METAL FILM
R 761	5322 116 50491	22,6	1	MR25	METAL FILM
R 762	5322 116 54619	10K	1	MR25	METAL FILM
R 763	5322 116 54624	11,5K	1	MR25	METAL FILM
R 764	5322 116 50527	33,2	1	MR25	METAL FILM
R 766	5322 116 50664	2,05K	1	MR25	METAL FILM
R 768	5322 116 54545	909	1	MR25	METAL FILM
R 769	5322 116 50527	33,2	1	MR25	METAL FILM
R 771	5322 116 50555	1,27K	1	MR25	METAL FILM
R 772	5322 116 54525	511	1	MR25	METAL FILM
R 773	5322 116 50527	33,2	1	MR25	METAL FILM
R 774	5322 116 50527	33,2	1	MR25	METAL FILM
R 776	5322 116 54549	1K	1	MR25	METAL FILM
R 777	4822 110 63189	1,2M	10	CR25	CARBON
R 778	5322 116 54696	100K	1	MR25	METAL FILM
R 779	5322 116 50731	10,5K	1	MR25	METAL FILM
R 781	5322 116 50527	33,2	1	MR25	METAL FILM
R 784	5322 116 50731	10,5K	1	MR25	METAL FILM
R 801	4822 111 30324	100	5	CR16	CARBON
R 802	5322 111 30396	22	5	CR16	CARBON
R 803	5322 116 54012	6,81K	1	MR25	METAL FILM
R 804	4822 111 30263	3,3K	5	CR16	CARBON
R 806	5322 116 50586	1,54K	1	MR25	METAL FILM
R 807	5322 116 50895	18,7	1	MR25	METAL FILM
R 808	5322 116 50895	18,7	1	MR25	METAL FILM
R 809	5322 111 30396	22	5	CR16	CARBON
R 811	5322 116 54012	6,81K	1	MR25	METAL FILM
R 812	5322 116 54525	511	1	MR25	METAL FILM
R 813	5322 111 30396	22	5	CR16	CARBON
R 814	5322 116 54592	4,02K	1	MR25	METAL FILM
R 816	5322 111 30396	22	5	CR16	CARBON
R 817	5322 116 50415	1,15K	1	MR25	METAL FILM
R 818	5322 116 50415	1,15K	1	MR25	METAL FILM
R 819	5322 111 30396	22	5	CR16	CARBON
R 821	4822 110 63054	10	5	CR25	CARBON
R 822	5322 116 54683	68,1K	1	MR25	METAL FILM
R 823	5322 116 50636	2,74K	1	MR25	METAL FILM
R 824	5322 116 54683	68,1K	1	MR25	METAL FILM
R 826	5322 116 54552	1,05K	1	MR25	METAL FILM
R 827	5322 116 50635	1,47K	1	MR25	METAL FILM
R 828	5322 116 50635	1,47K	1	MR25	METAL FILM
R 829	5322 116 54552	1,05K	1	MR25	METAL FILM
R 831	5322 111 30396	22	5	CR16	CARBON
R 832	5322 111 30396	22	5	CR16	CARBON
R 833	5322 116 50527	33,2	1	MR25	METAL FILM
R 834	5322 116 50506	154	1	MR25	METAL FILM
R 836	5322 116 54508	301	1	MR25	METAL FILM
R 837	5322 116 54552	1,05K	1	MR25	METAL FILM
R 838	5322 111 30396	22	5	CR16	CARBON
R 839	5322 116 54552	1,05K	1	MR25	METAL FILM
R 840	5322 111 30396	22	5	CR16	CARBON
R 841	5322 116 54576	2,37K	1	MR25	METAL FILM
R 842	5322 116 54519	402	1	MR25	METAL FILM
R 843	4822 110 63054	10	5	CR25	CARBON
R 844	4822 110 63054	10	5	CR25	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 851	4822 110 63036	2,2	5	CR25	CARBON
R 852	4822 110 63036	2,2	5	CR25	CARBON
R 853	4822 110 63036	2,2	5	CR25	CARBON
R 854	4822 110 63036	2,2	5	CR25	CARBON
R 856	5322 116 54564	1,5K	1	MR25	METAL FILM
R 857	5322 111 44156	510	5	CR16	CARBON
R 858	5322 116 54549	1K	1	MR25	METAL FILM
R 859	5322 116 54619	10K	1	MR25	METAL FILM
R 861	5322 116 54629	14K	1	MR25	METAL FILM
R 862	5322 111 34094	620	5	CR16	CARBON
R 863	4822 111 30303	8,2K	5	CR16	CARBON
R 864	4822 111 30267	1,5K	5	CR16	CARBON
R 866	4822 111 30119	3K	5	CR16	CARBON
R 867	5322 116 50561	590	1	MR25	METAL FILM
R 868	5322 116 54011	5,62K	1	MR25	METAL FILM
R 869	5322 116 54585	3,48K	1	MR25	METAL FILM
R 871	5322 111 44153	15	5	CR16	CARBON
R 872	5322 116 54474	110	1	MR25	METAL FILM
R 873	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 874	5322 116 54661	34,8K	1	MR25	METAL FILM
R 876	5322 116 54619	10K	1	MR25	METAL FILM
R 877	5322 116 54597	5,36K	1	MR25	METAL FILM
R 878	5322 116 50415	1,15K	1	MR25	METAL FILM
R 879	5322 116 54481	130	1	MR25	METAL FILM
R 880	5322 116 54585	3,48K	1	MR25	METAL FILM
R 881	5322 116 50676	196	1	MR25	METAL FILM
R 882	5322 116 54696	100K	1	MR25	METAL FILM
R 883	5322 116 54632	14,7K	1	MR25	METAL FILM
R 884	5322 116 54632	14,7K	1	MR25	METAL FILM
R 885	5322 116 50583	5,9K	1	MR25	METAL FILM
R 886	5322 116 50481	22,6K	1	MR25	METAL FILM
R 887	5322 116 50459	422	1	MR25	METAL FILM
R 888	5322 116 54005	3,32K	1	MR25	METAL FILM
R 889	5322 116 54603	6,49K	1	MR25	METAL FILM
R 890	5322 116 50527	33,2	1	MR25	METAL FILM
R 891	5322 116 50675	2,26K	1	MR25	METAL FILM
R 892	5322 116 54608	7,5K	1	MR25	METAL FILM
R 893	4822 111 30067	33	5	CR16	CARBON
R 894	5322 116 50509	4,87K	1	MR25	METAL FILM
R 895	5322 116 50586	1,54K	1	MR25	METAL FILM
R 897	5322 116 54519	402	1	MR25	METAL FILM
R 898	5322 116 54534	681	1	MR25	METAL FILM
R 899	5322 116 50636	2,74K	1	MR25	METAL FILM
R 900	4822 111 30067	33	5	CR16	CARBON
R 901	5322 116 54549	1K	1	MR25	METAL FILM
R 902	4822 111 30067	33	5	CR16	CARBON
R 903	5322 116 50527	33,2	1	MR25	METAL FILM
R 904	5322 116 50636	2,74K	1	MR25	METAL FILM
R 905	5322 116 54587	3,65K	1	MR25	METAL FILM
R 906	5322 111 30396	22	5	CR16	CARBON
R 907	5322 116 50556	4,42K	1	MR25	METAL FILM
R 908	4822 111 30067	33	5	CR16	CARBON
R 909	5322 116 50798	898	0,5	MR24C	METAL FILM
R 910	5322 116 54549	1K	1	MR25	METAL FILM
R 911	5322 116 50579	3,16K	1	MR25	METAL FILM
R 912	5322 116 50556	4,42K	1	MR25	METAL FILM
R 913	5322 116 50664	2,05K	1	MR25	METAL FILM
R 914	5322 100 10114	4,7K	20	0,5W	TRIMMING POTM
R 915	5322 116 54624	11,5K	1	MR25	METAL FILM
R 916	5322 116 50481	22,6K	1	MR25	METAL FILM
R 917	5322 116 54549	1K	1	MR25	METAL FILM
R 918	5322 116 54549	1K	1	MR25	METAL FILM
R 919	5322 116 50559	27,4K	1	MR25	METAL FILM
R 921	5322 116 50559	27,4K	1	MR25	METAL FILM
R 922	5322 116 50556	4,42K	1	MR25	METAL FILM
R 923	5322 116 50556	4,42K	1	MR25	METAL FILM
R 925	5322 116 54619	10K	1	MR25	METAL FILM
R 926	5322 116 54011	5,62K	1	MR25	METAL FILM
R 927	5322 116 54011	5,62K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 928	5322 111 30396	22	5	CR16	CARBON
R 929	5322 116 54627	13,3K	1	MR25	METAL FILM
R 931	4822 111 30352	82	5	CR16	CARBON
R 932	4822 111 30245	47	5	CR16	CARBON
R 933	5322 111 30396	22	5	CR16	CARBON
R 934	5322 111 30279	33K	5	CR16	CARBON
R 936	5322 116 54565	1,62K	1	MR25	METAL FILM
R 937	5322 111 44156	510	5	CR16	CARBON
R 939	5322 111 44156	510	5	CR16	CARBON
R 941	4822 111 30327	220	5	CR16	CARBON
R 942	5322 116 54632	14,7K	1	MR25	METAL FILM
R 944	5322 116 50664	2,05K	1	MR25	METAL FILM
R 946	5322 116 54608	7,5K	1	MR25	METAL FILM
R 948	5322 116 54617	9,53K	1	MR25	METAL FILM
R 949	5322 116 54576	2,37K	1	MR25	METAL FILM
R 961	5322 116 54408	909K	1	MR30	METAL FILM
R 962	5322 116 54762	365K	1	MR30	METAL FILM
R 963	5322 116 54939	35,2K	0,5	MR24C	METAL FILM
R 964	5322 116 55167	17,2K	0,5	MR24C	METAL FILM
R 966	5322 116 55168	8,16K	0,5	MR24C	METAL FILM
R 967	5322 116 54832	2,71K	0,5	MR24C	METAL FILM
R 968	5322 116 50798	898	0,5	MR24C	METAL FILM
R 969	5322 116 54722	182K	1	MR25	METAL FILM
R 971	5322 116 54977	89,8K	0,5	MR24C	METAL FILM
R 976	5322 116 50527	33,2	1	MR25	METAL FILM
R 977	5322 116 50729	4,22K	1	MR25	METAL FILM
R 978	5322 116 50451	21,5K	1	MR25	METAL FILM
R 979	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 981	5322 116 54005	3,32K	1	MR25	METAL FILM
R 982	5322 116 50527	33,2	1	MR25	METAL FILM
R 983	5322 116 50484	4,64K	1	MR25	METAL FILM
R 984	5322 116 50664	2,05K	1	MR25	METAL FILM
R 986	5322 116 54595	5,11K	1	MR25	METAL FILM
R 987	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 1001	4822 111 30324	100	5	CR16	CARBON
R 1002	5322 111 30396	22	5	CR16	CARBON
R 1003	5322 116 54012	6,81K	1	MR25	METAL FILM
R 1004	4822 111 30263	3,3K	5	CR16	CARBON
R 1006	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1007	5322 116 50895	18,7	1	MR25	METAL FILM
R 1008	5322 116 50895	18,7	1	MR25	METAL FILM
R 1009	5322 111 30396	22	5	CR16	CARBON
R 1011	5322 116 54012	6,81K	1	MR25	METAL FILM
R 1012	5322 116 54525	511	1	MR25	METAL FILM
R 1013	5322 111 30396	22	5	CR16	CARBON
R 1014	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1016	5322 111 30396	22	5	CR16	CARBON
R 1017	5322 116 50415	1,15K	1	MR25	METAL FILM
R 1018	5322 116 50415	1,15K	1	MR25	METAL FILM
R 1019	5322 111 30396	22	5	CR16	CARBON
R 1021	4822 110 63054	10	5	CR25	CARBON
R 1022	5322 116 54683	68,1K	1	MR25	METAL FILM
R 1023	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1024	5322 116 54683	68,1K	1	MR25	METAL FILM
R 1026	5322 116 54552	1,05K	1	MR25	METAL FILM
R 1027	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1028	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1029	5322 116 54552	1,05K	1	MR25	METAL FILM
R 1031	5322 111 30396	22	5	CR16	CARBON
R 1032	5322 111 30396	22	5	CR16	CARBON
R 1033	5322 116 50527	33,2	1	MR25	METAL FILM
R 1034	5322 116 50506	154	1	MR25	METAL FILM
R 1036	5322 116 54508	301	1	MR25	METAL FILM
R 1037	5322 116 54552	1,05K	1	MR25	METAL FILM
R 1038	5322 111 30396	22	5	CR16	CARBON
R 1039	5322 116 54552	1,05K	1	MR25	METAL FILM
R 1040	5322 111 30396	22	5	CR16	CARBON
R 1041	5322 116 54576	2,37K	1	MR25	METAL FILM
R 1042	5322 116 54519	402	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1043	4822 110 63054	10	5	CR25	CARBON
R 1044	4822 110 63054	10	5	CR25	CARBON
R 1051	4822 110 63036	2,2	5	CR25	CARBON
R 1052	4822 110 63036	2,2	5	CR25	CARBON
R 1053	4822 110 63063	22	5	CR25	CARBON
R 1054	4822 110 63036	2,2	5	CR25	CARBON
R 1055	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1056	5322 116 54576	2,37K	1	MR25	METAL FILM
R 1057	5322 116 54525	511	1	MR25	METAL FILM
R 1058	5322 116 54474	110	1	MR25	METAL FILM
R 1059	5322 111 44153	15	5	CR16	CARBON
R 1061	5322 116 54532	649	1	MR25	METAL FILM
R 1062	5322 116 50729	4,22K	1	MR25	METAL FILM
R 1063	5322 116 54011	5,62K	1	MR25	METAL FILM
R 1064	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 1065	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1066	5322 116 54629	14K	1	MR25	METAL FILM
R 1067	5322 116 54597	5,36K	1	MR25	METAL FILM
R 1068	5322 116 54597	5,36K	1	MR25	METAL FILM
R 1069	5322 116 50415	1,15K	1	MR25	METAL FILM
R 1070	5322 116 54516	365	1	MR25	METAL FILM
R 1071	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1072	5322 116 54519	402	1	MR25	METAL FILM
R 1073	5322 116 54545	909	1	MR25	METAL FILM
R 1074	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1075	5322 111 30396	22	5	CR16	CARBON
R 1076	5322 116 54597	5,36K	1	MR25	METAL FILM
R 1077	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1078	5322 116 54603	6,49K	1	MR25	METAL FILM
R 1079	5322 116 50767	2,15K	1	MR25	METAL FILM
R 1080	5322 100 10114	4,7K	20	0,5W	TRIMMING POTM
R 1081	4822 111 30067	33	5	CR16	CARBON
R 1082	5322 116 54608	7,5K	1	MR25	METAL FILM
R 1083	5322 116 54635	16,9K	1	MR25	METAL FILM
R 1084	4822 111 30067	33	5	CR16	CARBON
R 1085	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1086	5322 116 50798	898	0,5	MR24C	METAL FILM
R 1087	4822 111 30067	33	5	CR16	CARBON
R 1088	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1089	5322 116 50527	33,2	1	MR25	METAL FILM
R 1090	5322 116 54549	1K	1	MR25	METAL FILM
R 1091	4822 111 30067	33	5	CR16	CARBON
R 1092	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1093	5322 116 50556	4,42K	1	MR25	METAL FILM
R 1094	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1095	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1096	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1097	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 1098	5322 116 54549	1K	1	MR25	METAL FILM
R 1099	5322 111 30278	27K	5	CR16	CARBON
R 1101	4822 111 30352	82	5	CR16	CARBON
R 1102	4822 111 30245	47	5	CR16	CARBON
R 1103	5322 111 30396	22	5	CR16	CARBON
R 1104	5322 111 30396	22	5	CR16	CARBON
R 1106	5322 111 30279	33K	5	CR16	CARBON
R 1107	5322 116 54565	1,62K	1	MR25	METAL FILM
R 1108	5322 116 54576	2,37K	1	MR25	METAL FILM
R 1109	5322 116 50514	64,9K	1	MR25	METAL FILM
R 1111	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1112	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1113	5322 116 54576	2,37K	1	MR25	METAL FILM
R 1114	5322 116 54557	1,21K	1	MR25	METAL FILM
R 1115	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1116	5322 116 54469	100	1	MR25	METAL FILM
R 1117	5322 116 54561	1,33K	1	MR25	METAL FILM
R 1118	5322 116 54576	2,37K	1	MR25	METAL FILM
R 1119	5322 116 54617	9,53K	1	MR25	METAL FILM
R 1121	5322 116 54561	1,33K	1	MR25	METAL FILM
R 1122	5322 116 50524	3,01K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1123	5322 116 54561	1,33K	1	MR25	METAL FILM
R 1124	4822 111 30067	33	5	CR16	CARBON
R 1126	4822 111 30067	33	5	CR16	CARBON
R 1127	5322 116 54617	9,53K	1	MR25	METAL FILM
R 1128	5322 116 50583	5,9K	1	MR25	METAL FILM
R 1129	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1131	5322 116 54641	19,6K	1	MR25	METAL FILM
R 1132	5322 116 54663	37,4K	1	MR25	METAL FILM
R 1162	5322 116 54762	365K	1	MR30	METAL FILM
R 1163	5322 116 54939	35,2K	0,5	MR24C	METAL FILM
R 1164	5322 116 55167	17,2K	0,5	MR24C	METAL FILM
R 1166	5322 116 55168	8,16K	0,5	MR24C	METAL FILM
R 1167	5322 116 54832	2,71K	0,5	MR24C	METAL FILM
R 1168	5322 116 50798	898	0,5	MR24C	METAL FILM
R 1169	5322 116 54722	182K	1	MR25	METAL FILM
R 1171	5322 116 54977	89,8K	0,5	MR24C	METAL FILM
R 1201	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1202	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1203	5322 116 50484	4,64K	1	MR25	METAL FILM
R 1204	4822 111 30067	33	5	CR16	CARBON
R 1206	5322 116 54619	10K	1	MR25	METAL FILM
R 1207	5322 116 54576	2,37K	1	MR25	METAL FILM
R 1208	5322 116 54619	10K	1	MR25	METAL FILM
R 1209	5322 101 14008	2,2K	20	0,5W	TRIMMING POTM
R 1211	5322 116 50621	536	1	MR25	METAL FILM
R 1212	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1213	5322 116 50621	536	1	MR25	METAL FILM
R 1214	5322 116 50511	48,7	1	MR25	METAL FILM
R 1216	5322 116 50457	215	1	MR25	METAL FILM
R 1217	4822 111 30333	1M	10	CR16	CARBON
R 1218	4822 111 30333	1M	10	CR16	CARBON
R 1219	5322 116 54619	10K	1	MR25	METAL FILM
R 1221	5322 116 50511	48,7	1	MR25	METAL FILM
R 1222	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1223	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1224	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1225	5322 116 50728	1,87K	1	MR25	METAL FILM
R 1226	5322 116 54615	9,09K	1	MR25	METAL FILM
R 1227	5322 116 54541	825	1	MR25	METAL FILM
R 1228	5322 116 54541	825	1	MR25	METAL FILM
R 1229	4822 111 30067	33	5	CR16	CARBON
R 1231	5322 116 50583	5,9K	1	MR25	METAL FILM
R 1232	5322 116 54012	6,81K	1	MR25	METAL FILM
R 1233	5322 116 50555	1,27K	1	MR25	METAL FILM
R 1234	5322 116 54716	162K	1	MR25	METAL FILM
R 1236	4822 111 30067	33	5	CR16	CARBON
R 1237	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1238	4822 111 30067	33	5	CR16	CARBON
R 1239	5322 116 54549	1K	1	MR25	METAL FILM
R 1241	5322 116 54336	475K	1	MR30	METAL FILM
R 1242	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1243	4822 111 30067	33	5	CR16	CARBON
R 1244	5322 116 50451	21,5K	1	MR25	METAL FILM
R 1246	5322 116 54592	4,02K	1	MR25	METAL FILM
R 1247	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1248	4822 111 30067	33	5	CR16	CARBON
R 1249	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1251	5322 116 50481	22,6K	1	MR25	METAL FILM
R 1252	5322 116 54549	1K	1	MR25	METAL FILM
R 1253	5322 116 54188	1M	1	MR30	METAL FILM
R 1254	4822 111 30067	33	5	CR16	CARBON
R 1256	5322 116 54716	162K	1	MR25	METAL FILM
R 1257	4822 111 30067	33	5	CR16	CARBON
R 1258	5322 116 50555	1,27K	1	MR25	METAL FILM
R 1302	5322 116 54655	30,1K	1	MR25	METAL FILM
R 1303	5322 116 50414	2,87K	1	MR25	METAL FILM
R 1304	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1306	5322 116 54627	13,3K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1307	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1308	5322 116 50492	46,4	1	MR25	METAL FILM
R 1309	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1310	5322 116 55165	4,64K	1	MR30	METAL FILM
R 1311	5322 116 50491	22,6	1	MR25	METAL FILM
R 1312	4822 110 63187	1M	5	CR25	CARBON
R 1313	5322 116 54696	100K	1	MR25	METAL FILM
R 1314	5322 116 50559	27,4K	1	MR25	METAL FILM
R 1316	5322 116 50536	464	1	MR25	METAL FILM
R 1317	5322 116 54619	10K	1	MR25	METAL FILM
R 1318	5322 116 50559	27,4K	1	MR25	METAL FILM
R 1319	5322 116 50536	464	1	MR25	METAL FILM
R 1320	5322 116 54469	100	1	MR25	METAL FILM
R 1321	5322 116 50668	11,3K	1	MR25	METAL FILM
R 1322	5322 116 54561	1,33K	1	MR25	METAL FILM
R 1323	5322 116 50557	46,4K	1	MR25	METAL FILM
R 1324	5322 116 50668	11,3K	1	MR25	METAL FILM
R 1325	5322 116 54469	100	1	MR25	METAL FILM
R 1326	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1327	5322 116 54627	13,3K	1	MR25	METAL FILM
R 1328	5322 116 50492	46,4	1	MR25	METAL FILM
R 1329	5322 101 14008	2,2K	20	0,5W	TRIMMING POTM
R 1330	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1331	5322 116 54549	1K	1	MR25	METAL FILM
R 1332	4822 110 63187	1M	5	CR25	CARBON
R 1333	4822 110 63187	1M	5	CR25	CARBON
R 1334	5322 116 54469	100	1	MR25	METAL FILM
R 1335	4822 110 63161	100K	5	CR25	CARBON
R 1336	4822 110 42194	1,8M	5	VR37	CARBON
R 1337	4822 110 42203	3,9M	5	VR37	CARBON
R 1338	5322 101 14094	1M	20	0,5W	TRIMMING POTM
R 1339	5322 116 54738	274K	1	MR25	METAL FILM
R 1341	5322 101 14142	220K	20	0,5W	TRIMMING POTM
R 1342	5322 116 54716	162K	1	MR25	METAL FILM
R 1343	5322 116 54686	75K	1	MR25	METAL FILM
R 1344	5322 101 14142	220K	20	0,5W	TRIMMING POTM
R 1345	4822 116 30041	4	10	1W	NTC
R 1346	5322 116 50559	27,4K	1	MR25	METAL FILM
R 1350	4822 116 30041	4	10	1W	NTC
R 1356	5322 116 50559	27,4K	1	MR25	METAL FILM
R 1357	5322 116 50559	27,4K	1	MR25	METAL FILM
R 1358	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1359	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 1361	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1366	5322 116 54647	24,3K	1	MR25	METAL FILM
R 1367	5322 116 54003	22,1K	1	MR25	METAL FILM
R 1373	5322 116 54685	71,5K	1	MR25	METAL FILM
R 1374	5322 116 50731	10,5K	1	MR25	METAL FILM
R 1376	5322 116 54706	127K	1	MR25	METAL FILM
R 1377	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1386	5322 100 10114	4,7K	20	0,5W	TRIMMING POTM
R 1387	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1388	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1389	5322 116 54549	1K	1	MR25	METAL FILM
R 1390	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 1391	5322 116 50492	46,4	1	MR25	METAL FILM
R 1392	5322 116 50492	46,4	1	MR25	METAL FILM
R 1393	5322 116 50492	46,4	1	MR25	METAL FILM
R 1394	5322 116 50515	1,78K	1	MR25	METAL FILM
R 1396	5322 116 50415	1,15K	1	MR25	METAL FILM
R 1397	5322 116 50492	46,4	1	MR25	METAL FILM
R 1398	5322 116 50579	3,16K	1	MR25	METAL FILM
R 1399	5322 116 50635	1,47K	1	MR25	METAL FILM
R 1401	5322 116 50492	46,4	1	MR25	METAL FILM
R 1402	5322 116 50557	46,4K	1	MR25	METAL FILM
R 1403	5322 116 54549	1K	1	MR25	METAL FILM
R 1404	5322 116 50491	22,6	1	MR25	METAL FILM
R 1406	5322 116 50492	46,4	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1407	5322 116 54462	82,5	1	MR25	METAL FILM
R 1408	5322 116 54005	3,32K	1	MR25	METAL FILM
R 1409	5322 116 54493	182	1	MR25	METAL FILM
R 1411	5322 116 50671	2,61K	1	MR25	METAL FILM
R 1412	5322 116 54462	82,5	1	MR25	METAL FILM
R 1413	5322 116 50491	22,6	1	MR25	METAL FILM
R 1414	5322 116 50491	22,6	1	MR25	METAL FILM
R 1416	5322 116 54643	20,5K	1	MR25	METAL FILM
R 1417	5322 116 54426	121	1	MR25	METAL FILM
R 1418	5322 116 50451	21,5K	1	MR25	METAL FILM
R 1419	5322 116 54508	301	1	MR25	METAL FILM
R 1421	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1422	5322 116 54534	681	1	MR25	METAL FILM
R 1423	5322 116 50524	3,01K	1	MR25	METAL FILM
R 1424	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1426	5322 116 54492	178	1	MR25	METAL FILM
R 1427	5322 116 51052	42,2	1	MR25	METAL FILM
R 1428	5322 116 54508	301	1	MR25	METAL FILM
R 1429	5322 116 50571	715	1	MR25	METAL FILM
R 1501	5322 116 54665	40,2K	1	MR25	METAL FILM
R 1502	5322 116 50442	48,7K	1	MR25	METAL FILM
R 1503	5322 116 54683	68,1K	1	MR25	METAL FILM
R 1504	5322 116 50474	42,2K	1	MR25	METAL FILM
R 1506	5322 116 54549	1K	1	MR25	METAL FILM
R 1507	5322 116 54655	30,1K	1	MR25	METAL FILM
R 1508	5322 116 54632	14,7K	1	MR25	METAL FILM
R 1509	5322 116 50672	51,1K	1	MR25	METAL FILM
R 1516	5322 116 64015	7,5M	5	VR68	METAL OXIDE
R 1517	5322 116 64053	12M	5	VR68	METAL OXIDE
R 1518	4822 110 42187	1M	5	VR37	CARBON
R 1601	5322 116 54466	90,9	1	MR25	METAL FILM
R 1602	5322 116 54466	90,9	1	MR25	METAL FILM
R 1603	5322 116 50417	162	1	MR25	METAL FILM
R 1604	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1606	5322 116 50675	2,26K	1	MR25	METAL FILM
R 1607	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1608	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1609	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1610	5322 116 54525	511	1	MR25	METAL FILM
R 1611	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1612	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1613	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1614	5322 116 50636	2,74K	1	MR25	METAL FILM
R 1616	5322 116 54557	1,21K	1	MR25	METAL FILM
R 1617	5322 116 54557	1,21K	1	MR25	METAL FILM
R 1618	5322 116 50568	4,99	1	MR25	METAL FILM
R 1619	5322 116 50452	10	1	MR25	METAL FILM
R 1620	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1627	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1628	5322 116 54099	8,25	1	MR25	METAL FILM
R 1629	5322 116 54635	16,9K	1	MR25	METAL FILM
R 1630	5322 116 54455	68,1	1	MR25	METAL FILM
R 1631	5322 116 54606	7,15K	1	MR25	METAL FILM
R 1632	5322 116 54606	7,15K	1	MR25	METAL FILM
R 1633	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1634	5322 116 54549	1K	1	MR25	METAL FILM
R 1636	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1637	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1638	5322 116 54455	68,1	1	MR25	METAL FILM
R 1642	5322 116 54099	8,25	1	MR25	METAL FILM
R 1646	5322 116 54595	5,11K	1	MR25	METAL FILM
R 1647	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1648	5322 116 54099	8,25	1	MR25	METAL FILM
R 1649	5322 116 54635	16,9K	1	MR25	METAL FILM
R 1650	5322 116 54455	68,1	1	MR25	METAL FILM
R 1651	5322 116 54606	7,15K	1	MR25	METAL FILM
R 1652	5322 116 54606	7,15K	1	MR25	METAL FILM
R 1653	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1654	5322 116 54549	1K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1656	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1657	5322 116 54587	3,65K	1	MR25	METAL FILM
R 1658	5322 116 54455	68,1	1	MR25	METAL FILM
R 1662	5322 116 54099	8,25	1	MR25	METAL FILM
R 1802	4822 110 53029	1,2	5	CR37	CARBON
R 1803	5322 116 54743	301K	1	MR25	METAL FILM
R 1804	5322 116 54743	301K	1	MR25	METAL FILM
R 1805	5322 116 55149	24,9K	1	MR30	METAL FILM
R 1806	4822 110 63214	10M	10	CR25	CARBON
R 1807	4822 110 63196	2,2M	10	CR25	CARBON
R 1808	5322 116 54426	121	1	MR25	METAL FILM
R 1809	5322 116 54549	1K	1	MR25	METAL FILM
R 1810	5322 116 50557	46,4K	1	MR25	METAL FILM
R 1811	4822 112 21054	10	5	4,2W	WIRE-WOUND
R 1812	5322 116 54549	1K	1	MR25	METAL FILM
R 1813	5322 116 54619	10K	1	MR25	METAL FILM
R 1814	4822 110 53054	10	5	0,5W	CARBON
R 1815	5322 116 34028	150K	5	0,5W	NTC
R 1817	5322 116 50442	48,7K	1	MR25	METAL FILM
R 1818	5322 116 54965	82	5	PR52	METAL FILM
R 1819	5322 116 54619	10K	1	MR25	METAL FILM
R 1820	5322 116 54549	1K	1	MR25	METAL FILM
R 1821	5322 116 54549	1K	1	MR25	METAL FILM
R 1822	5322 116 50731	10,5K	1	MR25	METAL FILM
R 1823	5322 116 54529	619	1	MR25	METAL FILM
R 1824	5322 116 54549	1K	1	MR25	METAL FILM
R 1825	5322 116 54469	100	1	MR25	METAL FILM
R 1826	5322 116 54574	2,21K	1	MR25	METAL FILM
R 1827	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1828	5322 100 10115	1K	20	0,5W	TRIMMING POTM
R 1829	5322 116 50586	1,54K	1	MR25	METAL FILM
R 1830	5322 116 50669	205	1	MR25	METAL FILM
R 1831	5322 116 54558	8,25K	1	MR25	METAL FILM
R 1832	5322 116 50664	2,05K	1	MR25	METAL FILM
R 1833	5322 116 54906	75	1	MR30	METAL FILM
R 1834	5322 116 54619	10K	1	MR25	METAL FILM
R 1835	5322 116 54014	23,7	1	MR25	METAL FILM
R 1836	5322 116 50559	27,4K	1	MR25	METAL FILM
R 1837	5322 116 54696	100K	1	MR25	METAL FILM
R 1838	4822 110 63187	1M	5	CR25	CARBON
R 1839	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1840	5322 116 54192	5,1	5	CR25	METAL FILM
R 1841	5322 116 54469	100	1	MR25	METAL FILM
R 1842	5322 116 54469	100	1	MR25	METAL FILM
R 1843	5322 116 54738	274K	1	MR25	METAL FILM
R 1844	5322 116 54619	10K	1	MR25	METAL FILM
R 1845	4822 110 63045	4,7	5	CR25	CARBON
R 1846	5322 116 54726	200K	1	MR25	METAL FILM
R 1847	5322 116 54726	200K	1	MR25	METAL FILM
R 1848	5322 116 54525	511	1	MR25	METAL FILM
R 1849	5322 116 55097	47	5	PR37	METAL FILM
R 1851		22	20	0,5W	TRIMMING POTM
R 1852	5322 116 54069	12,1	1	MR25	METAL FILM
R 1853	5322 116 54069	12,1	1	MR25	METAL FILM
R 1857	5322 116 54696	100K	1	MR25	METAL FILM
R 1858	5322 116 50904	30,1	1	MR25	METAL FILM
R 1881	4822 112 21114	1,8K	5	4,2W	WIRE-WOUND
R 1882	5322 116 54648	24,9K	1	MR25	METAL FILM
R 1883	5322 116 54516	365	1	MR25	METAL FILM
R 1884	5322 116 54469	100	1	MR25	METAL FILM
R 1901	5322 116 50767	2,15K	1	MR25	METAL FILM
R 1902	5322 116 54589	3,83K	1	MR25	METAL FILM
R 1903	4822 111 30067	33	5	CR16	CARBON
R 1904	4822 111 30067	33	5	CR16	CARBON
R 1906	4822 111 30067	33	5	CR16	CARBON
R 1907	4822 111 30067	33	5	CR16	CARBON
R 1908	4822 111 30067	33	5	CR16	CARBON
R 1909	4822 111 30067	33	5	CR16	CARBON
R 1911	5322 116 50442	48,7K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 1912	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 1913	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1914	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1916	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1917	5322 116 50479	15,4K	1	MR25	METAL FILM
R 1918	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1919	5322 116 50608	6,19K	1	MR25	METAL FILM
R 1921	4822 111 30067	33	5	CR16	CARBON
R 1923	5322 116 54502	261	1	MR25	METAL FILM
R 1924	5322 116 54502	261	1	MR25	METAL FILM
R 1926	5322 116 54009	562	1	MR25	METAL FILM
R 1927	5322 116 50568	4,99	1	MR25	METAL FILM
R 1928	5322 116 54453	64,9	1	MR25	METAL FILM
R 1929	5322 116 54444	53,6	1	MR25	METAL FILM
R 1931	5322 100 10143	1K	20	0,75W	TRIMMING POTM
R 1932	5322 116 54453	64,9	1	MR25	METAL FILM
R 1933	5322 116 54444	53,6	1	MR25	METAL FILM
R 1934	5322 116 50555	1,27K	1	MR25	METAL FILM
R 1936	4822 111 30067	33	5	CR16	CARBON
R 1937	5322 116 54561	1,33K	1	MR25	METAL FILM
R 1938	5322 116 50731	10,5K	1	MR25	METAL FILM
R 1941	4822 111 30067	33	5	CR16	CARBON
R 1942	4822 111 30245	47	5	CR16	CARBON
R 1943	5322 116 54519	402	1	MR25	METAL FILM
R 1944	5322 116 50452	10	1	MR25	METAL FILM
R 1946	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 1947	5322 116 50442	48,7K	1	MR25	METAL FILM
R 1948	5322 116 54554	1,1K	1	MR25	METAL FILM
R 1949	5322 116 50452	10	1	MR25	METAL FILM
R 1951	4822 111 30245	47	5	CR16	CARBON
R 1952	5322 116 54549	1K	1	MR25	METAL FILM
R 1953	4822 111 30067	33	5	CR16	CARBON
R 1954	5322 116 54571	1,96K	1	MR25	METAL FILM
R 1956	4822 111 30067	33	5	CR16	CARBON
R 1957	5322 116 54617	9,53K	1	MR25	METAL FILM
R 1958	5322 116 50581	2,49K	1	MR25	METAL FILM
R 1959	5322 116 50452	10	1	MR25	METAL FILM
R 1960	4822 111 30067	33	5	CR16	CARBON
R 1961	5322 116 54519	402	1	MR25	METAL FILM
R 1962	4822 111 30245	47	5	CR16	CAPBON
R 1963	5322 116 54554	1,1K	1	MR25	METAL FILM
R 1964	4822 111 30245	47	5	CR16	CARBON
R 1966	5322 116 50452	10	1	MR25	METAL FILM
R 1967	4822 111 30067	33	5	CR16	CARBON
R 1968	5322 116 54619	10K	1	MR25	METAL FILM
R 1969	5322 116 54571	1,96K	1	MR25	METAL FILM
R 1971	4822 111 30067	33	5	CR16	CARBON
R 1972	5322 116 54538	787	1	MR25	METAL FILM
R 1973	4822 111 30067	33	5	CR16	CARBON
R 1974	4822 111 30067	33	5	CR16	CARBON
R 2001	5322 116 50527	33,2	1	MR25	METAL FILM
R 2002	5322 100 10143	1K	20	0,75W	TRIMMING POTM
R 2006	5322 116 54476	115	1	MR25	METAL FILM
R 2007	5322 116 54444	53,6	1	MR25	METAL FILM
R 2008	5322 100 10112	1K	20	0,5W	TRIMMING POTM
R 2009	5322 116 54476	115	1	MR25	METAL FILM
R 2011	5322 116 54444	53,6	1	MR25	METAL FILM
R 2012	5322 116 50527	33,2	1	MR25	METAL FILM
R 2013	4822 111 30067	33	5	CR16	CARBON
R 2014	5322 116 50635	1,47K	1	MR25	METAL FILM
R 2016	5322 116 50635	1,47K	1	MR25	METAL FILM
R 2017	4822 111 30067	33	5	CR16	CARBON
R 2018	4822 111 30245	47	5	CR16	CARBON
R 2019	5322 116 54494	187	1	MR25	METAL FILM
R 2021	5322 116 54549	1K	1	MR25	METAL FILM
R 2022	5322 116 54536	750	1	MR25	METAL FILM
R 2023	4822 111 30067	33	5	CR16	CARBON
R 2024	4822 111 30067	33	5	CR16	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 2025	5322 116 54565	1,62K	1	MR25	METAL FILM
R 2026	5322 116 50586	1,54K	1	MR25	METAL FILM
R 2027	5322 116 54497	226	1	MR25	METAL FILM
R 2028	4822 111 30067	33	5	CR16	CARBON
R 2029	5322 116 54549	1K	1	MR25	METAL FILM
R 2031	5322 116 54549	1K	1	MR25	METAL FILM
R 2032	5322 116 50586	1,54K	1	MR25	METAL FILM
R 2033	4822 111 30067	33	5	CR16	CARBON
R 2034	5322 116 54504	274	1	MR25	METAL FILM
R 2036	4822 111 30245	47	5	CR16	CARBON
R 2037	5322 116 54595	5,11K	1	MR25	METAL FILM
R 2038	4822 111 30067	33	5	CR16	CARBON
R 2039	5322 116 50592	442	1	MR25	METAL FILM
R 2041	5322 116 50492	46,4	1	MR25	METAL FILM
R 2042	5322 116 54513	332	1	MR25	METAL FILM
R 2043	5322 116 54536	750	1	MR25	METAL FILM
R 2044	4822 111 30067	33	5	CR16	CARBON
R 2101	5322 116 54469	100	1	MR25	METAL FILM
R 2102	5322 116 50482	33,2K	1	MR25	METAL FILM
R 2103	5322 116 54469	100	1	MR25	METAL FILM
R 2104	4822 110 63196	2,2M	10	CR25	CARBON
R 2106	5322 116 50479	15,4K	1	MR25	METAL FILM
R 2107	5322 100 10114	4,7K	20	0,5W	TRIMMING POTM
R 2108	5322 116 54655	30,1K	1	MR25	METAL FILM
R 2109	5322 116 50484	4,64K	1	MR25	METAL FILM
R 2111	5322 116 54732	237K	1	MR25	METAL FILM
R 2112	4822 110 60184	750K	5	CR25	CARBON
R 2113	5322 116 54619	10K	1	MR25	METAL FILM
R 2114	5322 116 50586	1,54K	1	MR25	METAL FILM
R 2116	5322 116 54712	147K	1	MR25	METAL FILM
R 2117	5322 116 50636	2,74K	1	MR25	METAL FILM
R 2118	5322 116 50415	1,15K	1	MR25	METAL FILM
R 2119	5322 116 54549	1K	1	MR25	METAL FILM
R 2121	5322 116 50481	22,6K	1	MR25	METAL FILM
R 2122	5322 116 54592	4,02K	1	MR25	METAL FILM
R 2123	5322 116 50664	2,05K	1	MR25	METAL FILM
R 2124	5322 100 10114	4,7K	20	0,5W	TPIMMING POTM
R 2126	5322 116 54619	10K	1	MR25	METAL FILM
R 2127	5322 116 54008	4,75K	1	MR25	METAL FILM
R 2128	5322 101 14008	2,2K	20	0,5W	TRIMMING POTM
R 2129	5322 116 54674	53,6K	1	MR25	METAL FILM
R 2131	5322 101 14142	220K	20	0,5W	TRIMMING POTM
R 2132	5322 116 54629	14K	1	MR25	METAL FILM
R 2133	5322 116 54696	100K	1	MR25	METAL FILM
R 2134	5322 116 50664	2,05K	1	MR25	METAL FILM
R 2136	5322 116 54696	100K	1	MR25	METAL FILM
R 2137	5322 116 54661	34,8K	1	MR25	METAL FILM
R 2138	5322 116 54661	34,8K	1	MR25	METAL FILM
R 2139	5322 116 54674	53,6K	1	MR25	METAL FILM
R 2140	5322 116 54549	1K	1	MR25	METAL FILM
R 2141	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 2142	5322 116 54661	34,8K	1	MR25	METAL FILM
R 2143	5322 116 54743	301K	1	MR25	METAL FILM
R 2144	5322 116 54696	100K	1	MR25	METAL FILM
R 2146	5322 116 54469	100	1	MR25	METAL FILM
R 2147	5322 116 50729	4,22K	1	MR25	METAL FILM
R 2148	5322 116 54549	1K	1	MR25	METAL FILM
R 2149	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 2151	5322 116 50571	715	1	MR25	METAL FILM
R 2153	5322 116 50556	4,42K	1	MR25	METAL FILM
R 2154	5322 116 54696	100K	1	MR25	METAL FILM
R 2156	5322 116 54671	47,5K	1	MR25	METAL FILM
R 2157	5322 116 50536	464	1	MR25	METAL FILM
R 2158	5322 116 54732	237K	1	MR25	METAL FILM
R 2159	4822 110 60184	750K	5	CR25	CARBON
R 2161	5322 116 54619	10K	1	MR25	METAL FILM
R 2162	5322 116 54619	10K	1	MR25	METAL FILM
R 2163	5322 116 54595	5,11K	1	MR25	METAL FILM
R 2164	5322 116 54595	5,11K	1	MR25	METAL FILM

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 2166	4822 110 63178	470K	5	CR25	CARBON
R 2167	5322 101 14142	220K	20	0,5W	TRIMMING POTM
R 2168	5322 101 14069	22K	20	0,5W	TRIMMING POTM
R 2169	5322 116 54005	3,32K	1	MR25	METAL FILM
R 2170	5322 116 54008	4,75K	1	MR25	METAL FILM
R 2171	5322 116 54005	3,32K	1	MR25	METAL FILM
R 2172	5322 116 54006	392	1	MR25	METAL FILM
R 2173	5322 116 54649	25,5K	1	MR25	METAL FILM
R 2178	5322 116 54008	4,75K	1	MR25	METAL FILM
R 2179	5322 116 54661	34,8K	1	MR25	METAL FILM
R 2181	5322 116 54696	100K	1	MR25	METAL FILM
R 2182	5322 116 54619	10K	1	MR25	METAL FILM
R 2183	5322 116 54629	14K	1	MR25	METAL FILM
R 2184	5322 116 54006	392	1	MR25	METAL FILM
R 2186	5322 116 50452	10	1	MR25	METAL FILM
R 2187	5322 116 50442	48,7K	1	MR25	METAL FILM
R 2188	5322 116 50572	12,1K	1	MR25	METAL FILM
R 2189	5322 100 10114	4,7K	20	0,5W	TRIMMING POTM
R 2191	5322 116 50572	12,1K	1	MR25	METAL FILM
R 2192	5322 116 50442	48,7K	1	MR25	METAL FILM
R 2193	5322 116 50593	16,2K	1	MR25	METAL FILM
R 2194	5322 116 50593	16,2K	1	MR25	METAL FILM
R 2196	5322 116 54655	30,1K	1	MR25	METAL FILM
R 2197	5322 116 55164	22,6K	1	MR30	METAL FILM
R 2198	5322 116 54549	1K	1	MR25	METAL FILM
R 2199	5322 116 54549	1K	1	MR25	METAL FILM
R 2201	5322 116 54469	100	1	MR25	METAL FILM
R 2202	5322 116 54639	19,1K	1	MR25	METAL FILM
R 2203	5322 116 50608	6,19K	1	MR25	METAL FILM
R 2204	5322 116 54502	261	1	MR25	METAL FILM
R 2206	5322 116 50608	6,19K	1	MR25	METAL FILM
R 2207	5322 116 54469	100	1	MR25	METAL FILM
R 2208	5322 116 54533	665	1	MR25	METAL FILM
R 2209	5322 100 10114	4,7K	20	0,5W	TRIMMING POTM
R 2211	5322 116 54576	2,37K	1	MR25	METAL FILM
R 2212	5322 116 54524	499	1	MR25	METAL FILM
R 2301	5322 116 50524	3,01K	1	MR25	METAL FILM
R 2302	5322 116 54508	301	1	MR25	METAL FILM
R 2303	4822 111 30067	33	5	CR16	CARBON
R 2304	5322 116 50524	3,01K	1	MR25	METAL FILM
R 2306	4822 111 30347	10	5	CR16	CARBON
R 2307	5322 116 50492	46,4	1	MR25	METAL FILM
R 2308	5322 116 54464	86,6	1	MR25	METAL FILM
R 2309	5322 116 34036	47	5	0,5W	NTC
R 2311	5322 116 50492	46,4	1	MR25	METAL FILM
R 2312	5322 116 50568	4,99	1	MR25	METAL FILM
R 2313	5322 116 54464	86,6	1	MR25	METAL FILM
R 2314	4822 111 30347	10	5	CR16	CARBON
R 2316	4822 111 30067	33	5	CR16	CARBON
R 2317	5322 116 50515	1,78K	1	MR25	METAL FILM
R 2319	5322 116 54005	3,32K	1	MR25	METAL FILM
R 2322	5322 116 50452	10	1	MR25	METAL FILM
R 2323	5322 116 50571	715	1	MR25	METAL FILM
R 2324	4822 111 30245	47	5	CR16	CARBON
R 2326	4822 111 30067	33	5	CR16	CARBON
R 2327	4822 111 30067	33	5	CR16	CARBON
R 2328	5322 116 54576	2,37K	1	MR25	METAL FILM
R 2329	5322 116 54587	3,65K	1	MR25	METAL FILM
R 2331	4822 111 30067	33	5	CR16	CARBON
R 2332	4822 111 30067	33	5	CR16	CARBON
R 2333	5322 116 50571	715	1	MR25	METAL FILM
R 2334	4822 111 30245	47	5	CR16	CARBON
R 2336	5322 116 50452	10	1	MR25	METAL FILM
R 2337	5322 116 50442	48,7K	1	MR25	METAL FILM
R 2338	5322 100 10113	10K	20	0,5W	TRIMMING POTM
R 2339	4822 111 30067	33	5	CR16	CARBON
R 2341	5322 116 54492	178	1	MR25	METAL FILM
R 2342	4822 110 63067	33	5	CR25	CARBON
R 2343	4822 111 30067	33	5	CR16	CARBON

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
R 2344	5322 116 54492	178	1	MR25	METAL FILM
R 2346	4822 110 63067	33	5	CR25	CARBON
R 2347	5322 116 54515	348	1	MR25	METAL FILM
R 2348	5322 116 54005	3,32K	1	MR25	METAL FILM
R 2349	4822 111 30067	33	5	CR16	CARBON
R 2351	5322 116 54613	8,66K	1	MR25	METAL FILM
R 2352	5322 116 50926	40,2	1	MR25	METAL FILM
R 2353	5322 116 50926	40,2	1	MR25	METAL FILM
R 2354	5322 116 50556	4,42K	1	MR25	METAL FILM
R 2356	5322 100 10143	1K	20	0,75W	TRIMMING POTM
R 2357	5322 116 54589	3,83K	1	MR25	METAL FILM
R 2358	5322 116 54519	402	1	MR25	METAL FILM
R 2359	5322 116 54012	6,81K	1	MR25	METAL FILM
R 2361	5322 116 50483	38,3K	1	MR25	METAL FILM
R 2362	5322 101 14048	47K	20	0,5W	TRIMMING POTM
R 2363	4822 111 30067	33	5	CR16	CARBON
R 2364	5322 116 50481	22,6K	1	MR25	METAL FILM
R 2366	4822 111 30324	100	5	CR16	CARBON
R 2367	5322 116 50452	10	1	MR25	METAL FILM
R 2368	5322 116 50926	40,2	1	MR25	METAL FILM
R 2369	5322 116 50926	40,2	1	MR25	METAL FILM
R 2371	4822 111 30324	100	5	CR16	CARBON
R 2372	5322 116 50527	33,2	1	MR25	METAL FILM
R 2373	5322 116 54585	3,48K	1	MR25	METAL FILM
R 2374	5322 116 50581	2,49K	1	MR25	METAL FILM
R 2375	4822 111 30067	33	5	CR16	CARBON
R 2376	5322 116 54585	3,48K	1	MR25	METAL FILM
R 2377	5322 116 54585	3,48K	1	MR25	METAL FILM
R 2378	5322 116 50581	2,49K	1	MR25	METAL FILM
R 2379	5322 116 54585	3,48K	1	MR25	METAL FILM
R 2380	4822 111 30067	33	5	CR16	CARBON
R 2381	5322 116 50527	33,2	1	MR25	METAL FILM
R 2391	4822 111 30067	33	5	CR16	CARBON
R 2392	4822 111 30067	33	5	CR16	CARBON
R 2393	5322 116 54469	100	1	MR25	METAL FILM
R 2394	4822 111 30067	33	5	CR16	CARBON
R 2397	5322 116 54469	100	1	MR25	METAL FILM
R 2398	5322 116 50621	536	1	MR25	METAL FILM
R 2399	4822 111 30067	33	5	CR16	CARBON
R 2401	5322 116 50524	3,01K	1	MR25	METAL FILM
R 2402	5322 116 54613	8,66K	1	MR25	METAL FILM
R 2404	5322 116 54469	100	1	MR25	METAL FILM
R 2413	4822 111 30324	100	5	CR16	CARBON
R 2414	4822 111 30324	100	5	CR16	CARBON
R 2416	4822 111 30067	33	5	CR16	CARBON
R 2417	5322 116 54536	750	1	MR25	METAL FILM
R 2418	5322 116 54536	750	1	MR25	METAL FILM
R 2419	5322 116 54005	3,32K	1	MR25	METAL FILM
R 2421	4822 111 30067	33	5	CR16	CARBON
R 2422	5322 116 54608	7,5K	1	MR25	METAL FILM
R 2423	5322 116 50492	46,4	1	MR25	METAL FILM
R 2424	5322 116 50492	46,4	1	MR25	METAL FILM
R 2426	5322 116 50675	2,26K	1	MR25	METAL FILM
R 2427	5322 116 50414	2,87K	1	MR25	METAL FILM
R 2428	5322 100 10143	1K	20	0,75W	TRIMMING POTM
R 2429	5322 116 50676	196	1	MR25	METAL FILM
R 2431	5322 116 50676	196	1	MR25	METAL FILM
R 2432	4822 111 30067	33	5	CR16	CARBON
R 2433	4822 111 30067	33	5	CR16	CARBON
R 2434	5322 116 54536	750	1	MR25	METAL FILM
R 2436	5322 116 54536	750	1	MR25	METAL FILM
R 2437	5322 116 54005	3,32K	1	MR25	METAL FILM
R 2438	4822 111 30067	33	5	CR16	CARBON
R 2439	5322 116 54608	7,5K	1	MR25	METAL FILM
R 2441	5322 116 54561	1,33K	1	MR25	METAL FILM
R 2442	5322 116 54504	274	1	MR25	METAL FILM
R 2444	5322 116 54462	82,5	1	MR25	METAL FILM
R 2446	5322 116 54504	274	1	MR25	METAL FILM
R 2447	5322 116 50581	2,49K	1	MR25	METAL FILM
R 2448	5322 116 54561	1,33K	1	MR25	METAL FILM
R 2449	4822 111 30067	33	5	CR16	CARBON

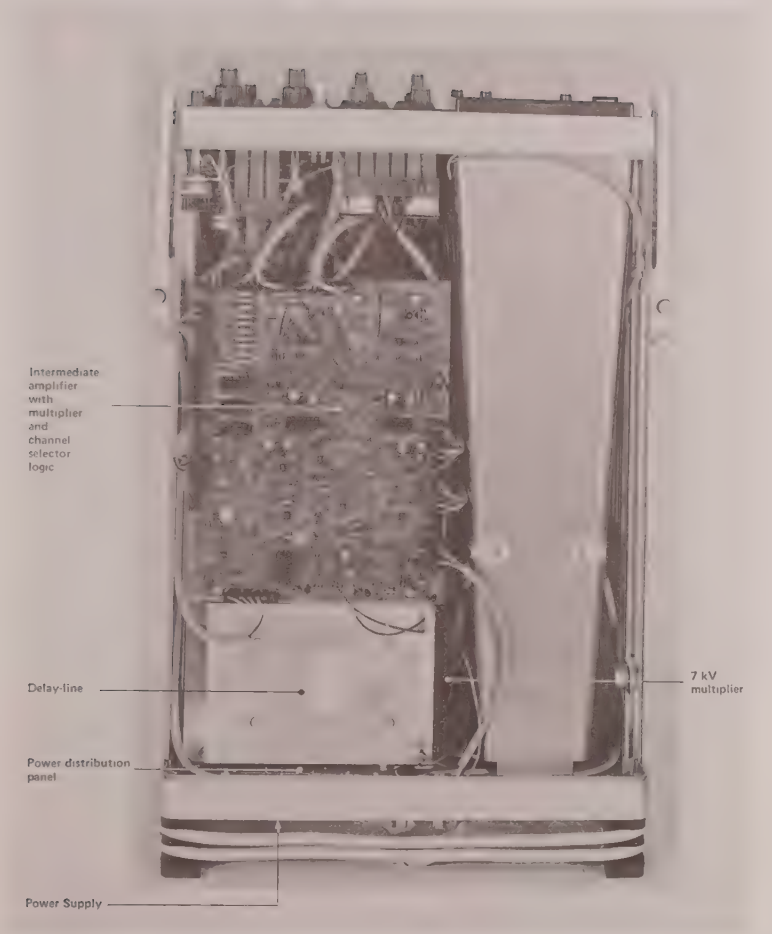


Fig. 3.15. Unit location, top view

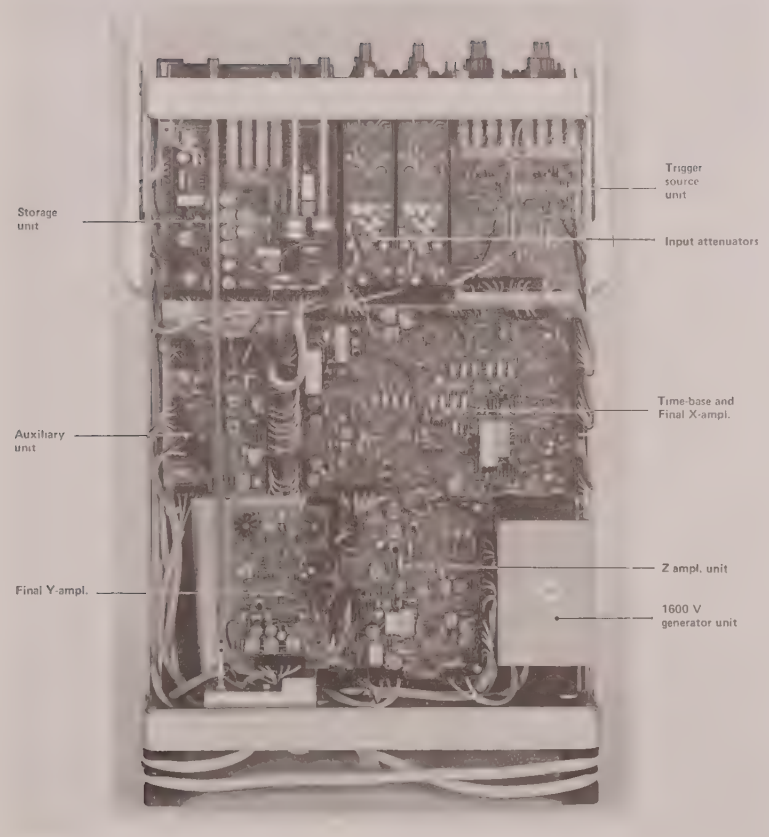


Fig. 3.16. Unit location, bottom view

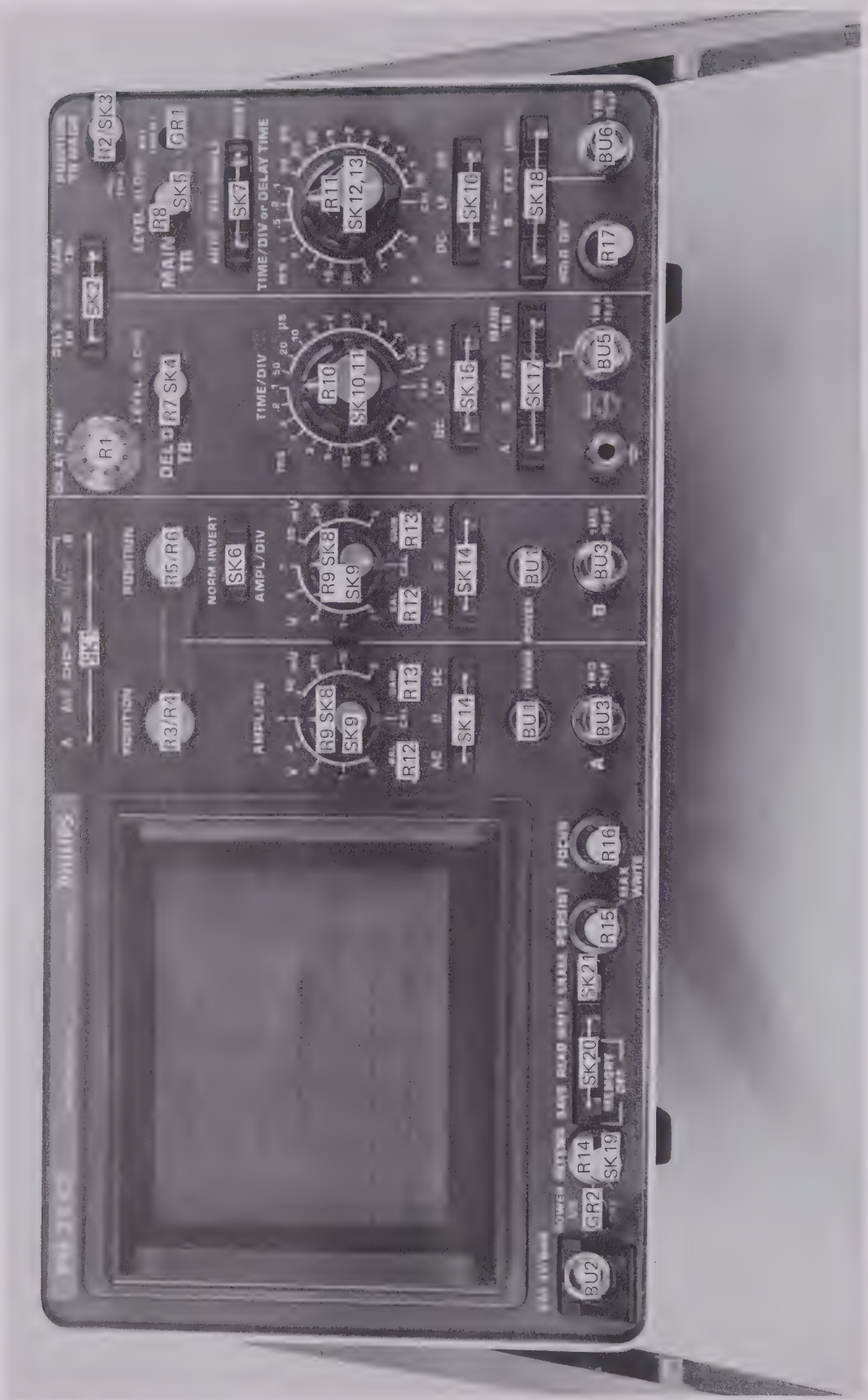


Fig. 3.17. Electrical item numbers, front plate

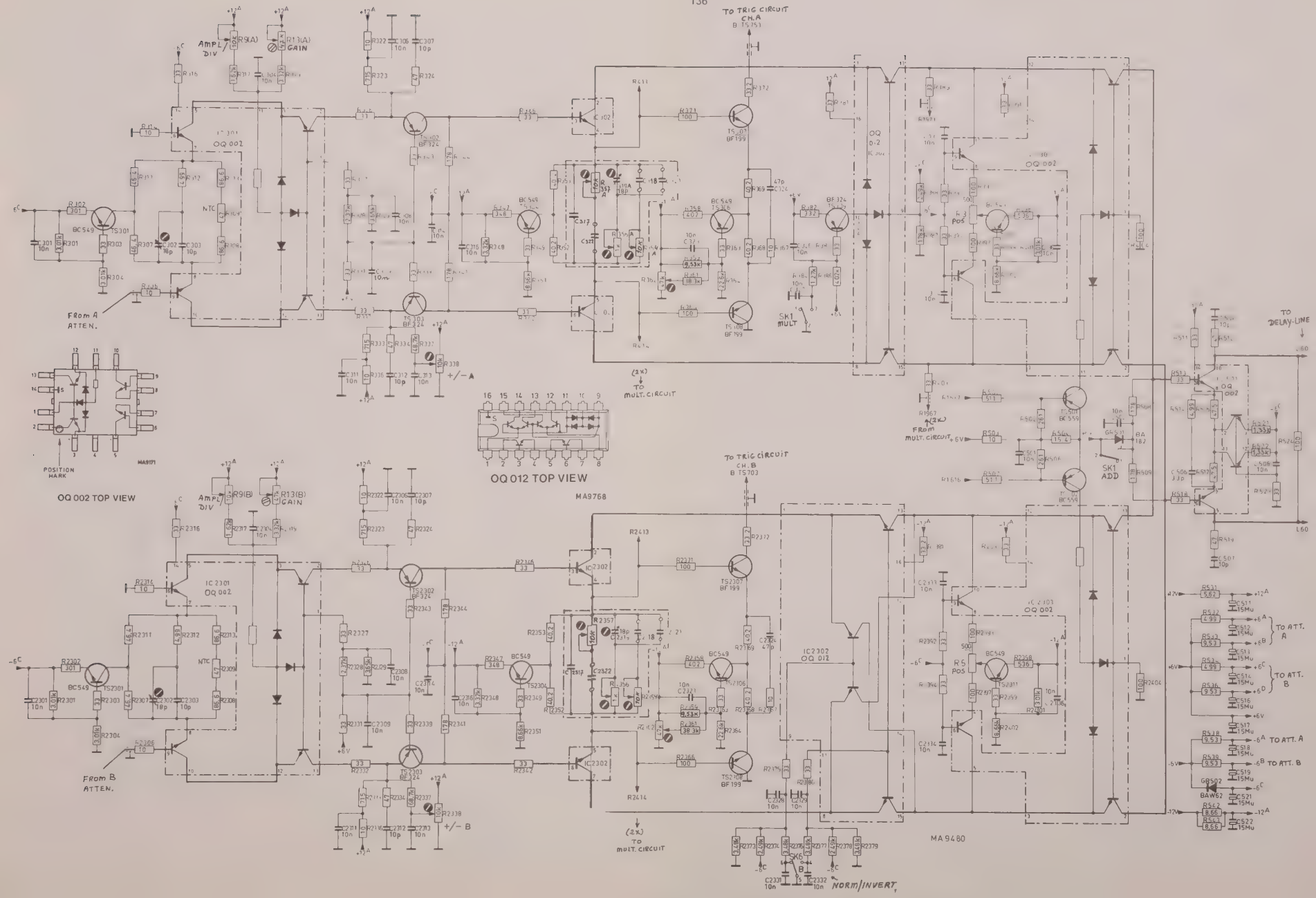


Fig. 3.20. Circuit diagram intermediate amplifier

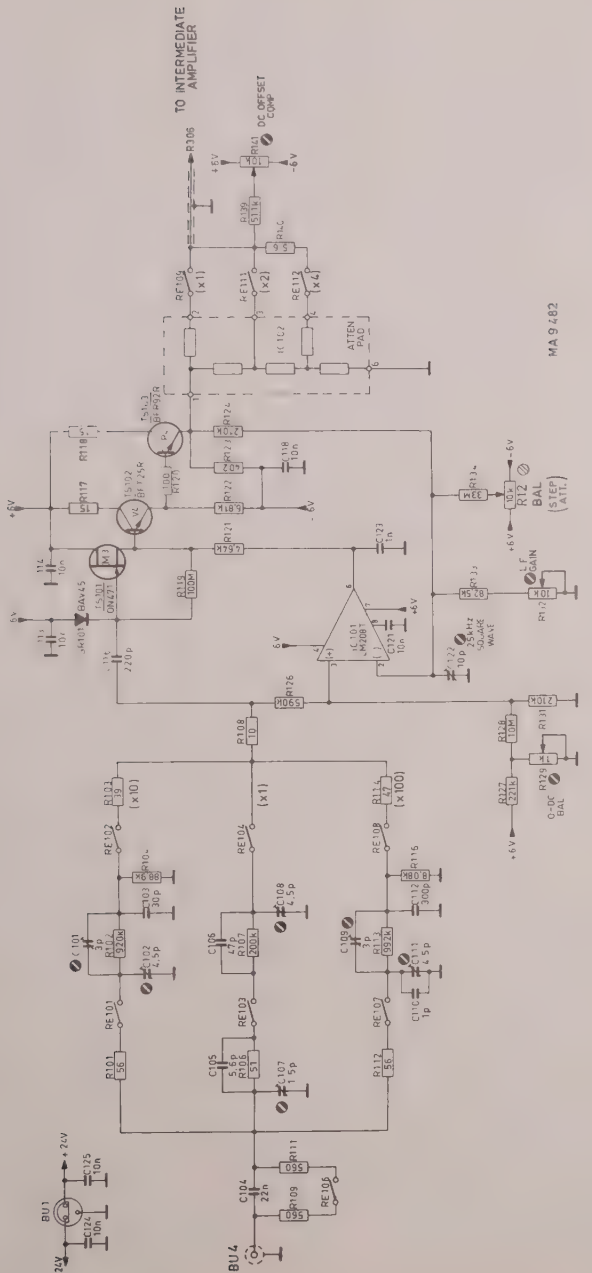


Fig. 3.18. Circuit diagram attenuator

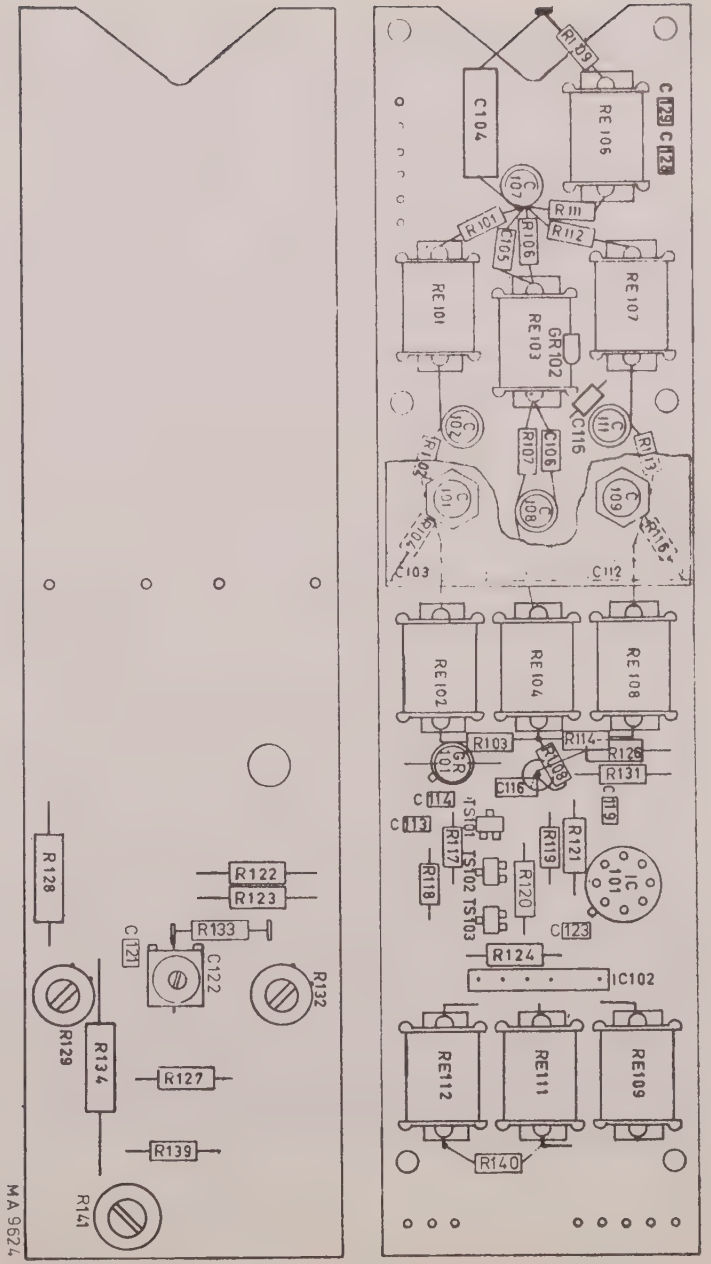


Fig. 3.19. Component lay-out attenuator

Fig. 3.21. Component lay-out intermediate amplifier with multiplier

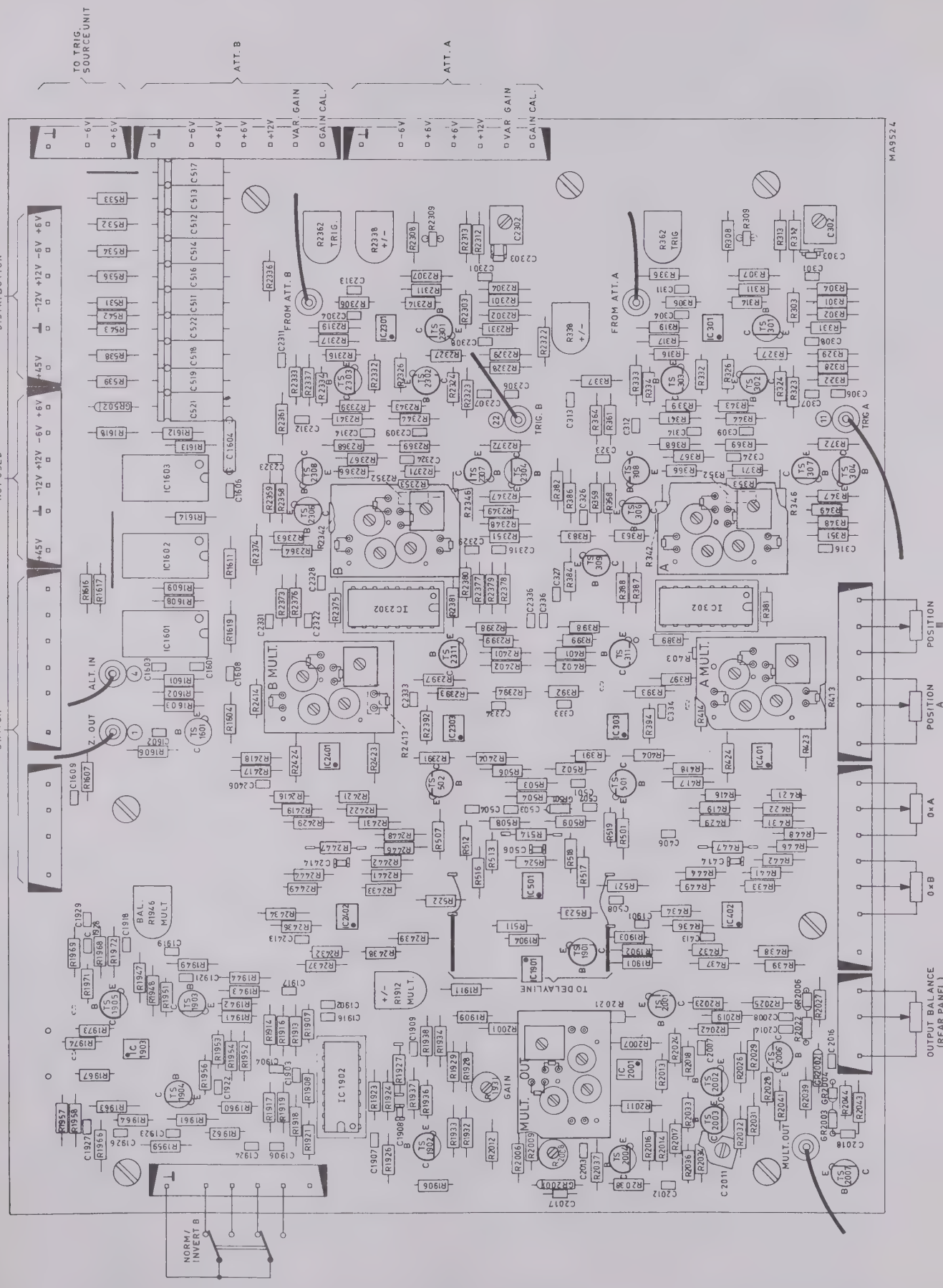


Fig. 3.22. As Fig. 3.21. but with incorporated H.F. compensation circuits

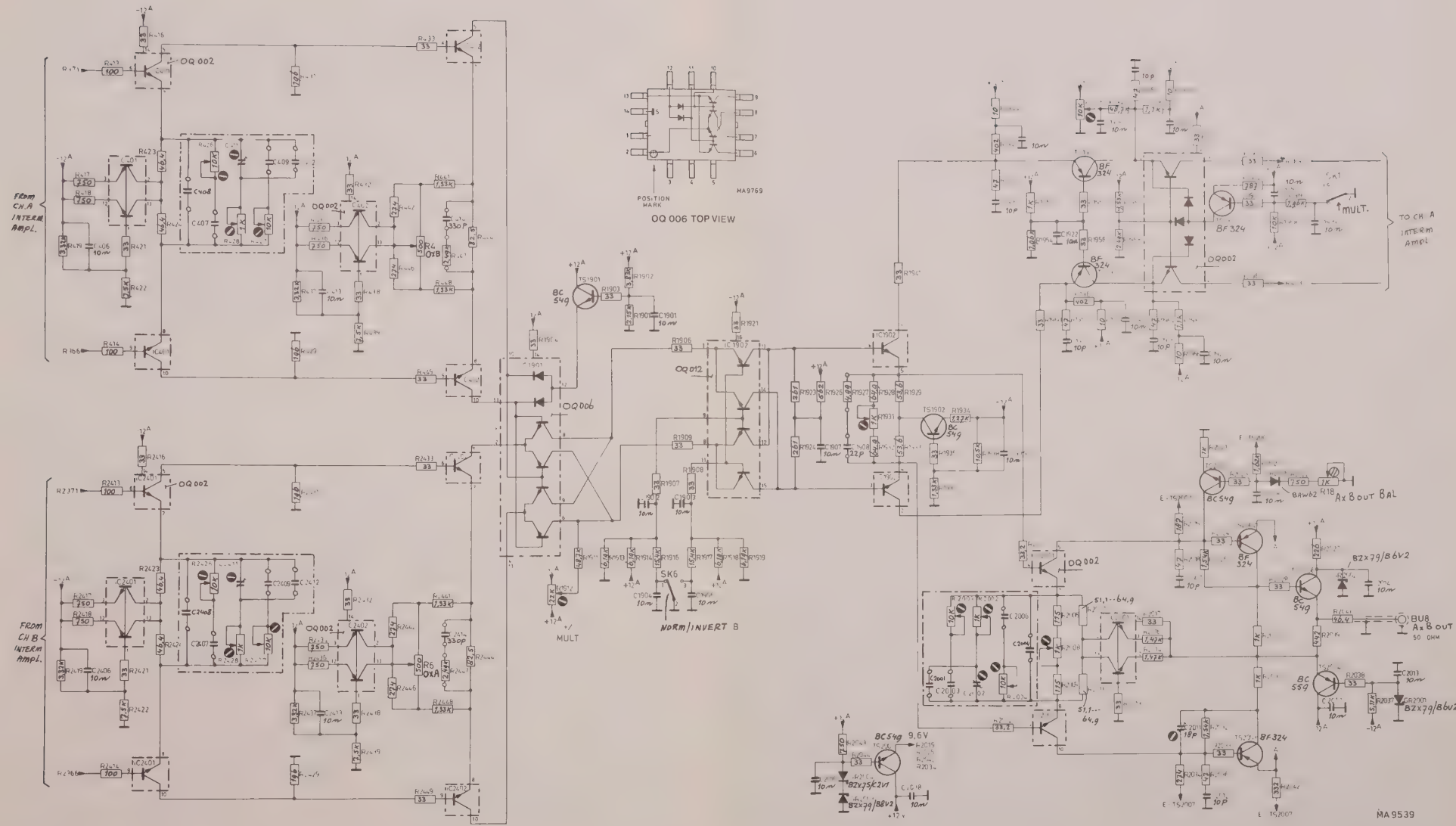


Fig. 3.23. Circuit diagram multiplier

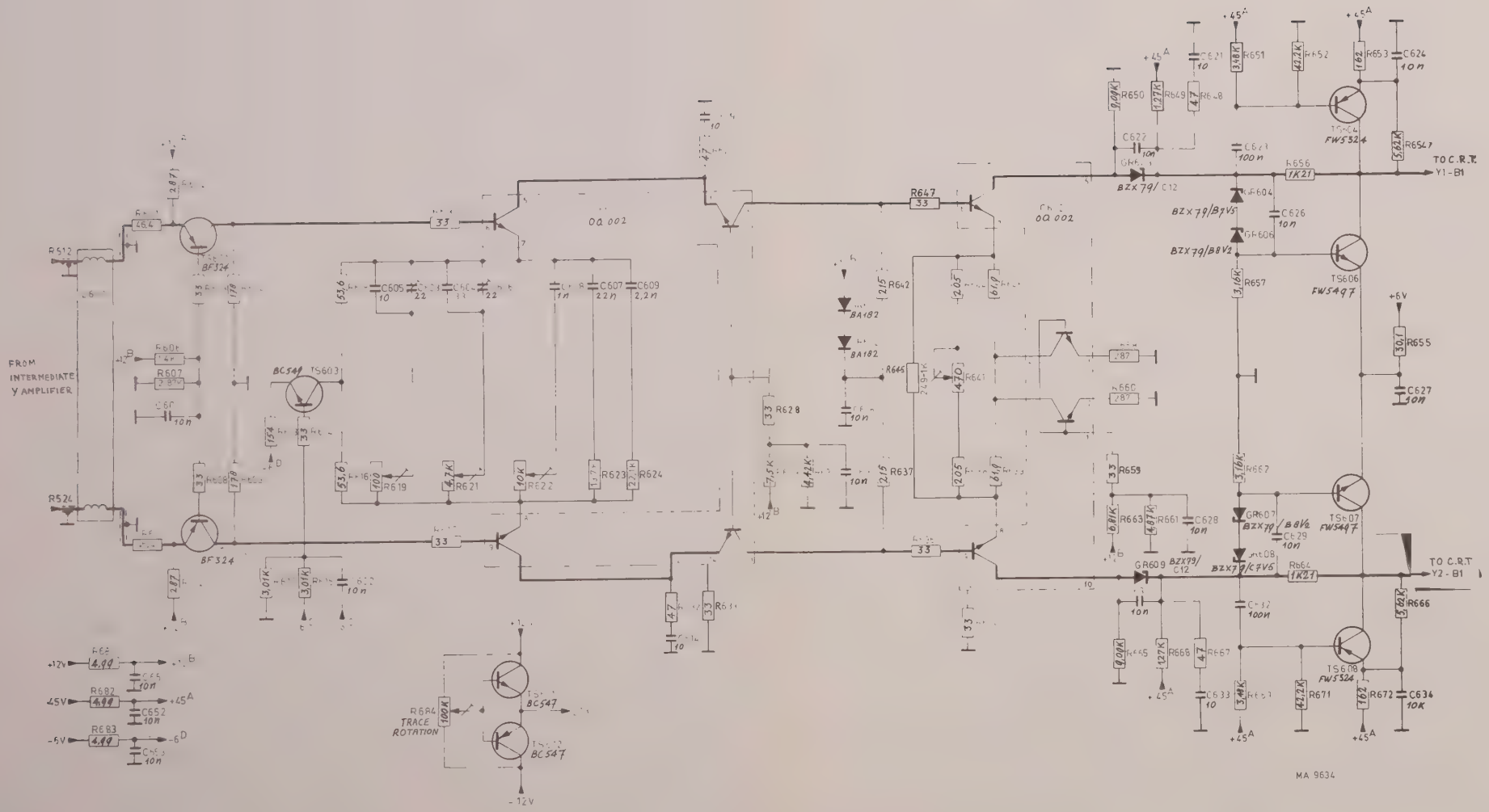


Fig. 3.24. Circuit diagram final Y amplifier

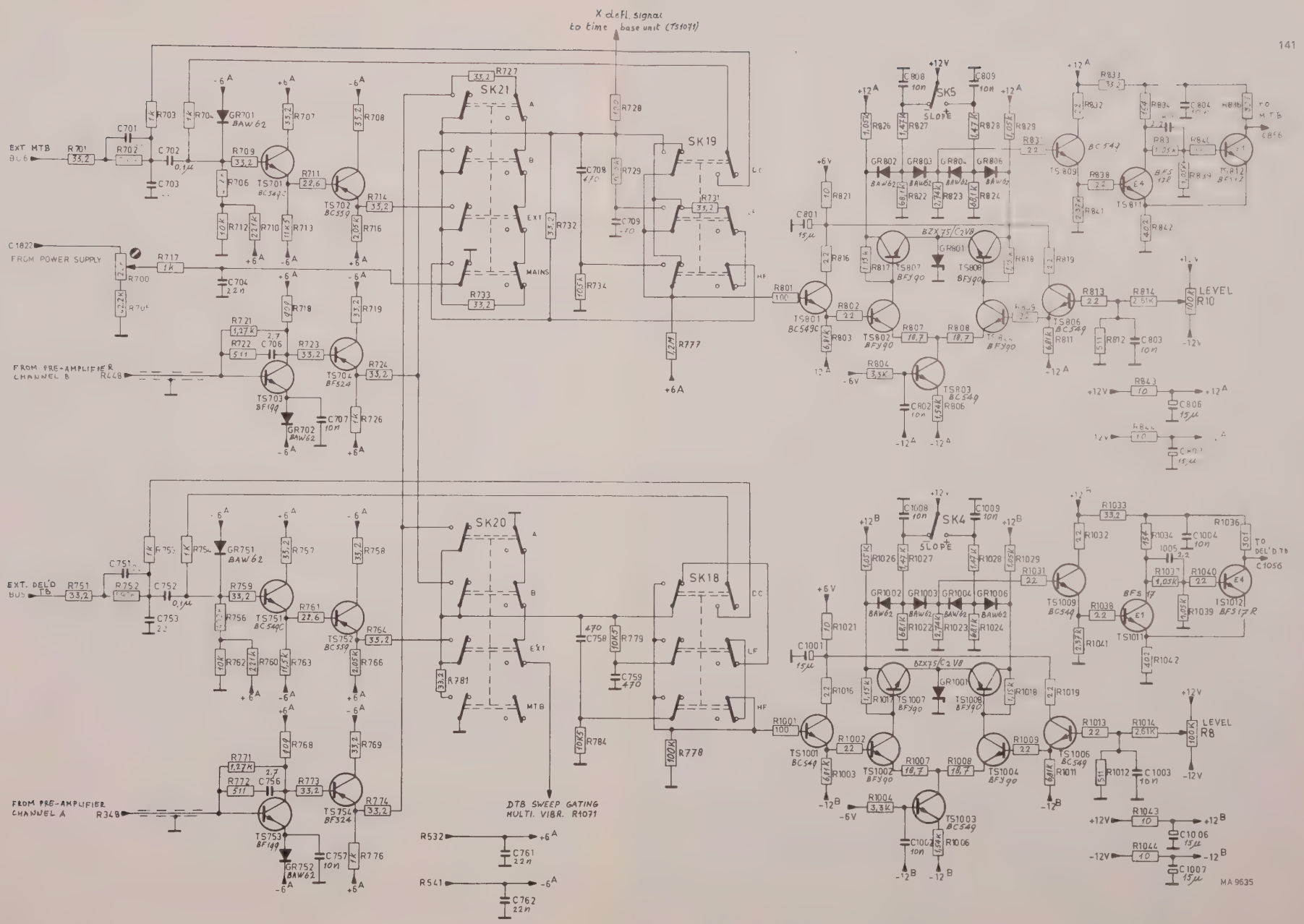


Fig. 3.25. Circuit diagram trigger source unit

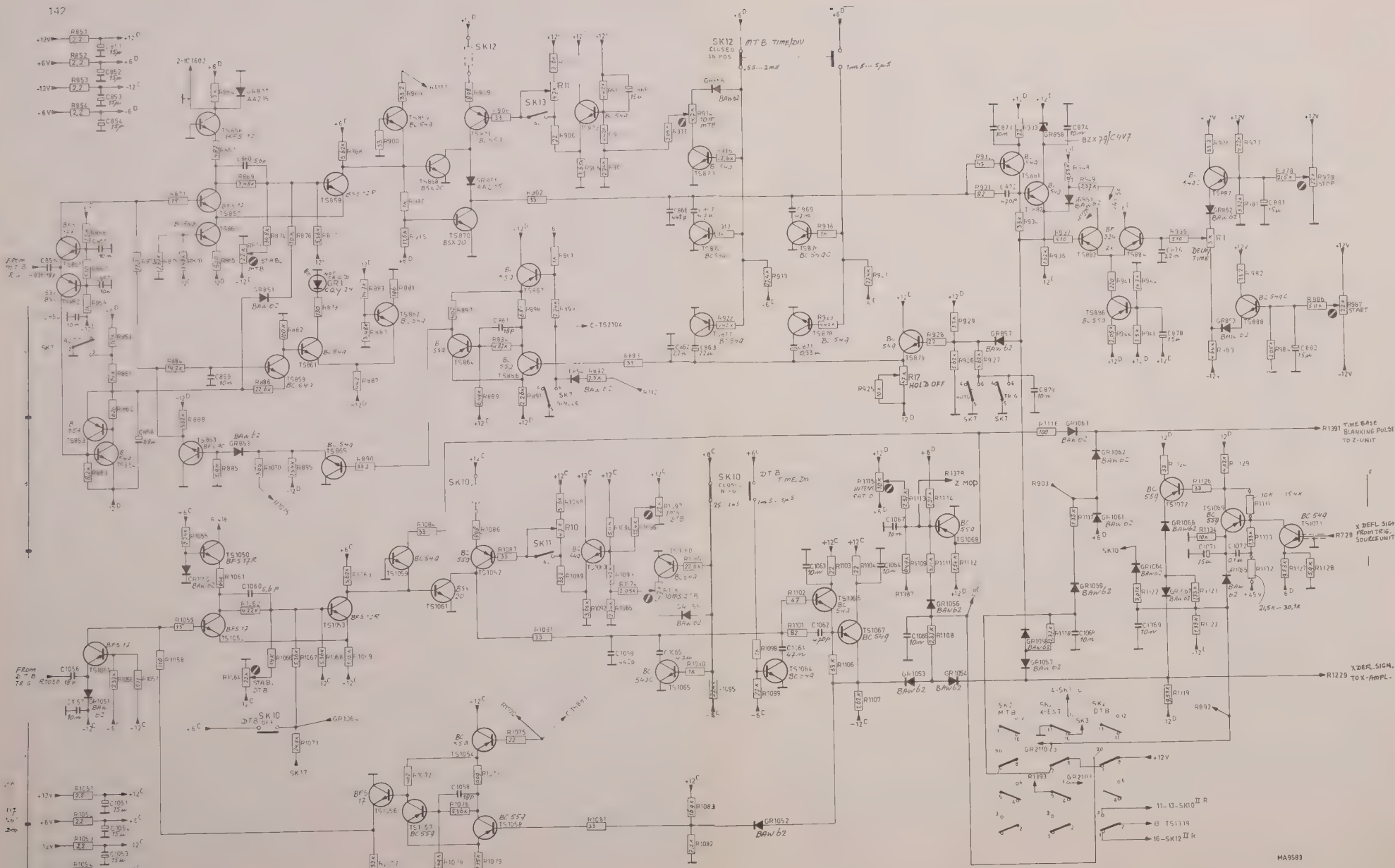


Fig. 3.26. Circuit diagram time-base

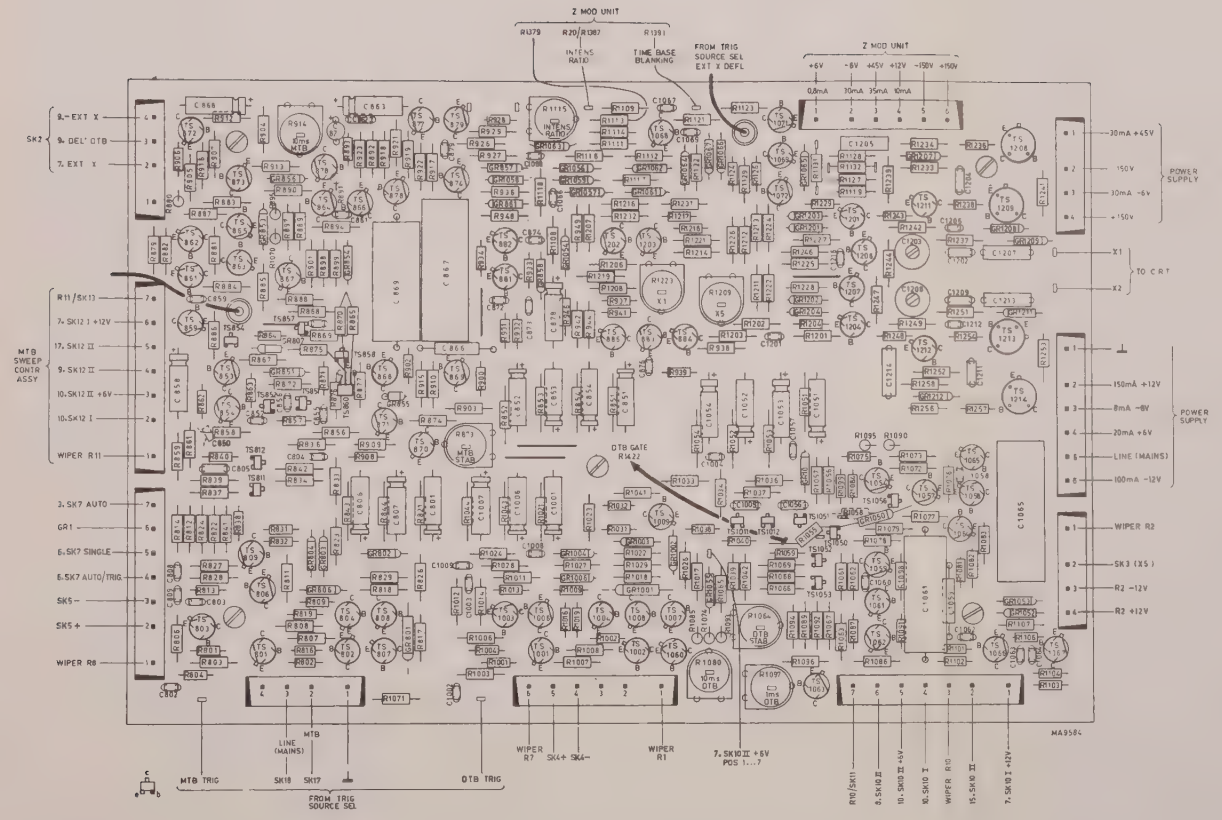


Fig. 3.27. Component lay-out time-base and X-amplifier

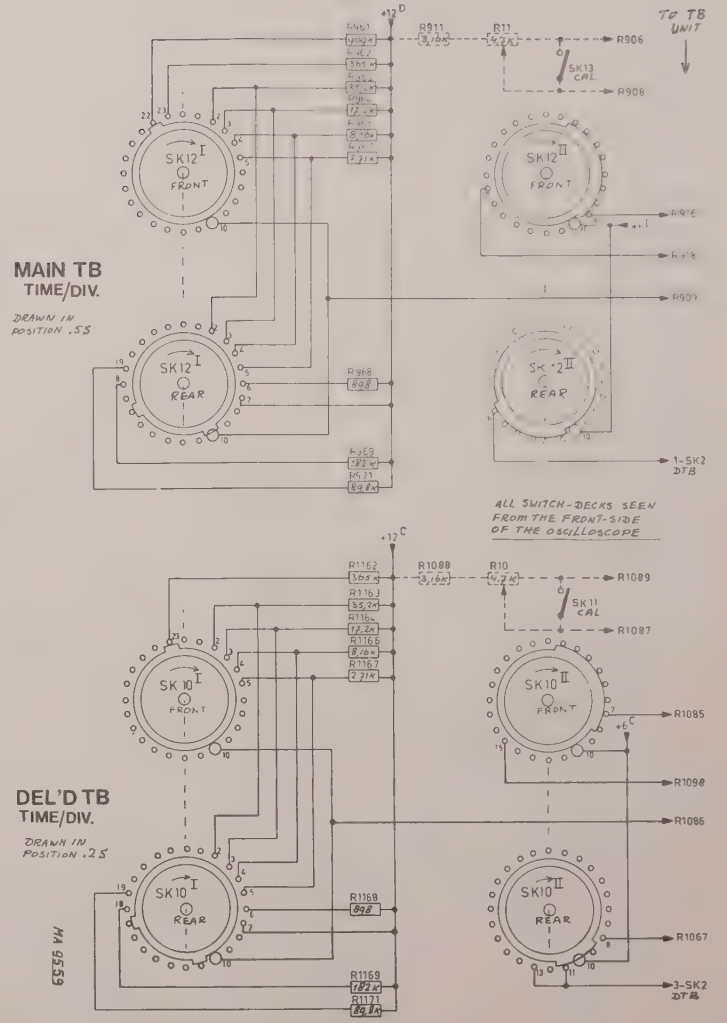


Fig. 3.28. Circuit diagram Main- and Delayed time-base sweep switches

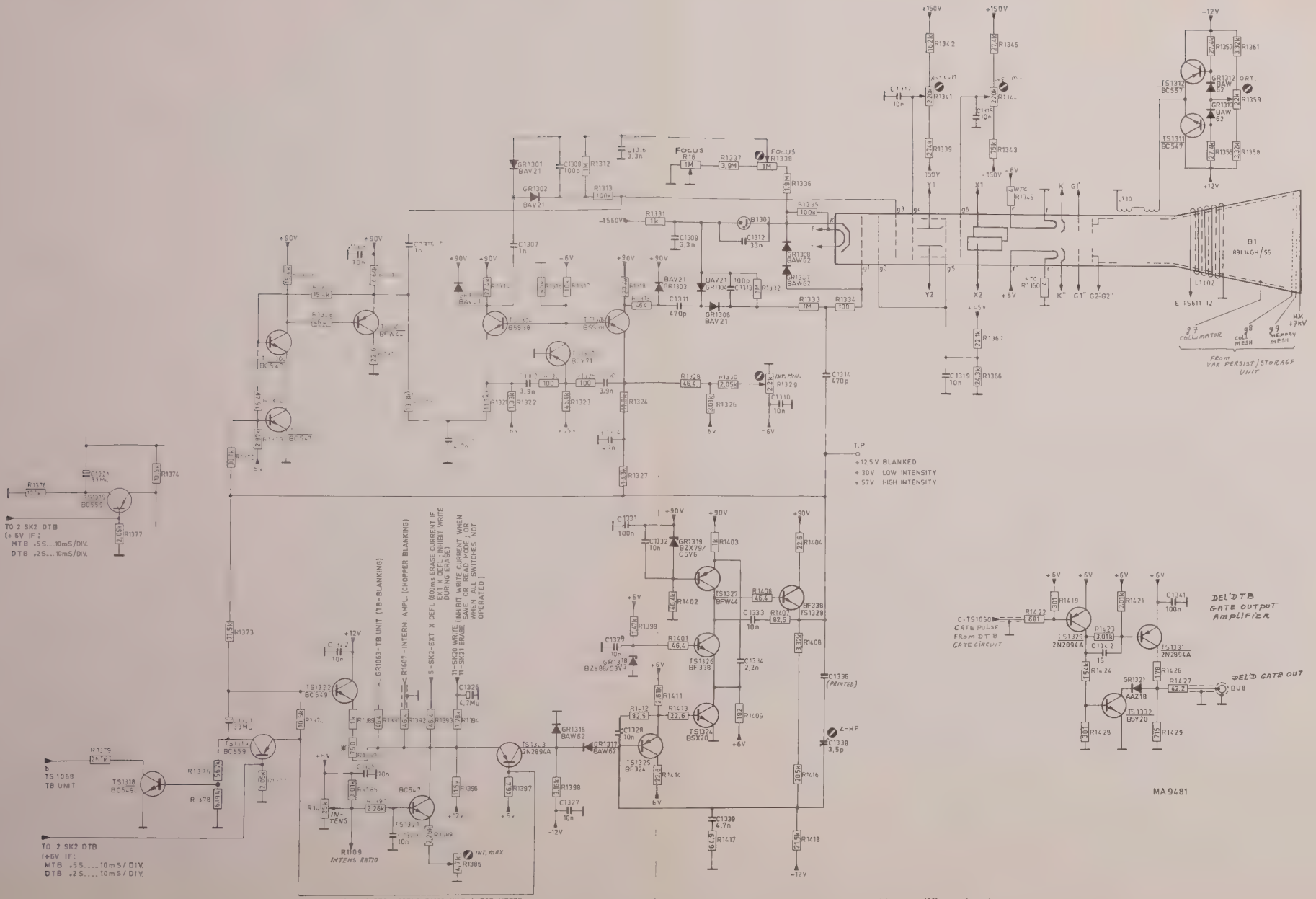


Fig. 3.29. Circuit diagram blanking amplifier and c.r.t.

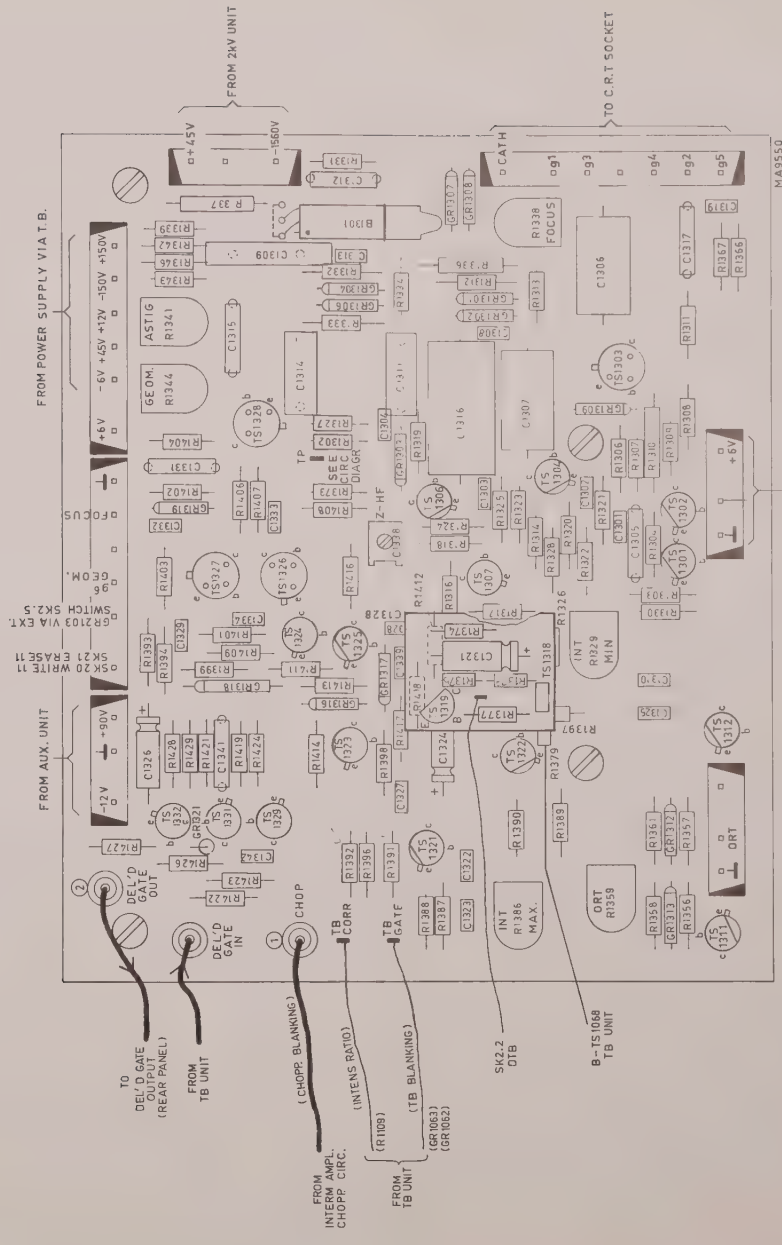


Fig. 3.30. Component lay-out blanking amplifier

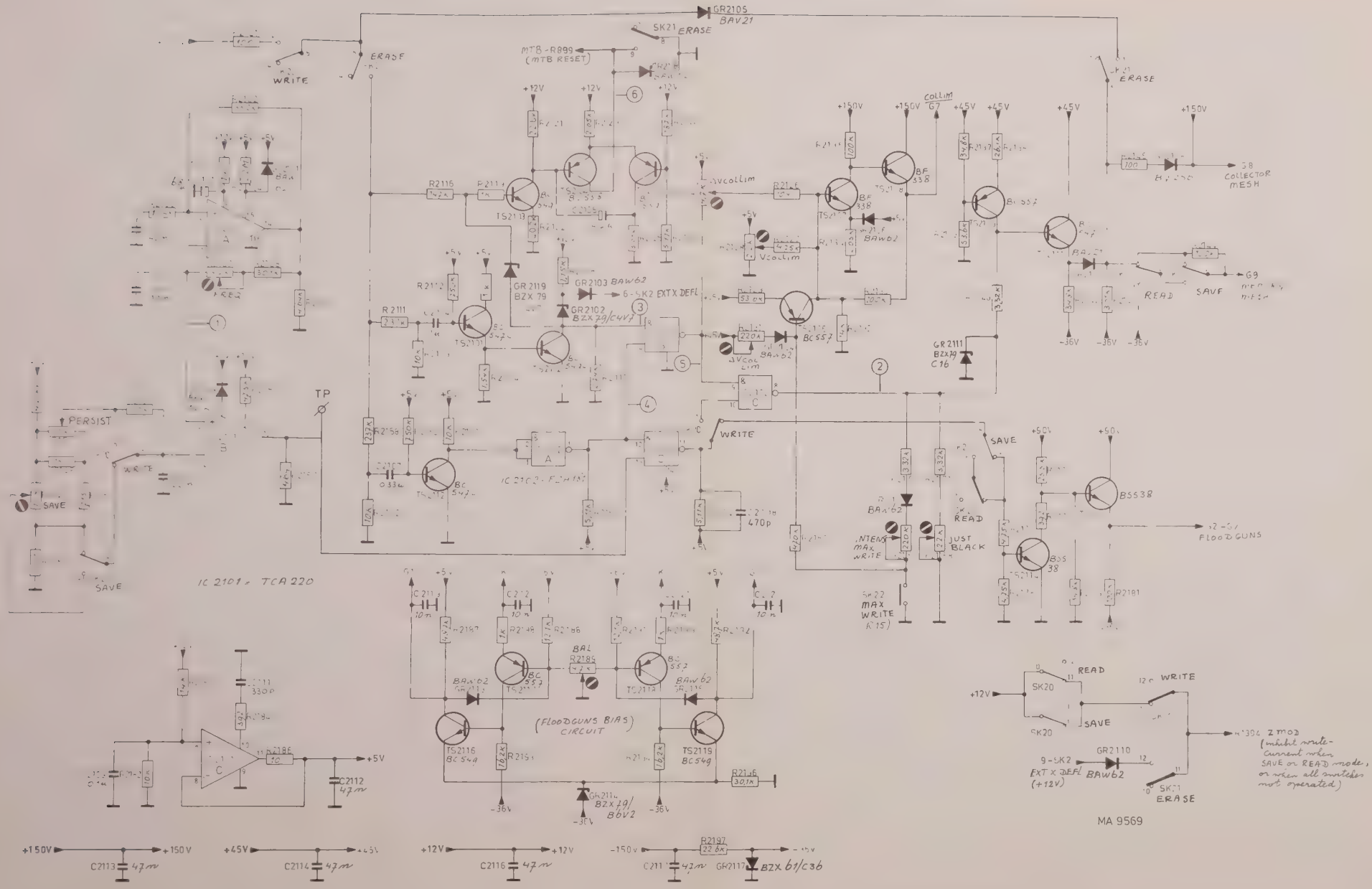


Fig. 3.31. Circuit diagram variable persistance/storage

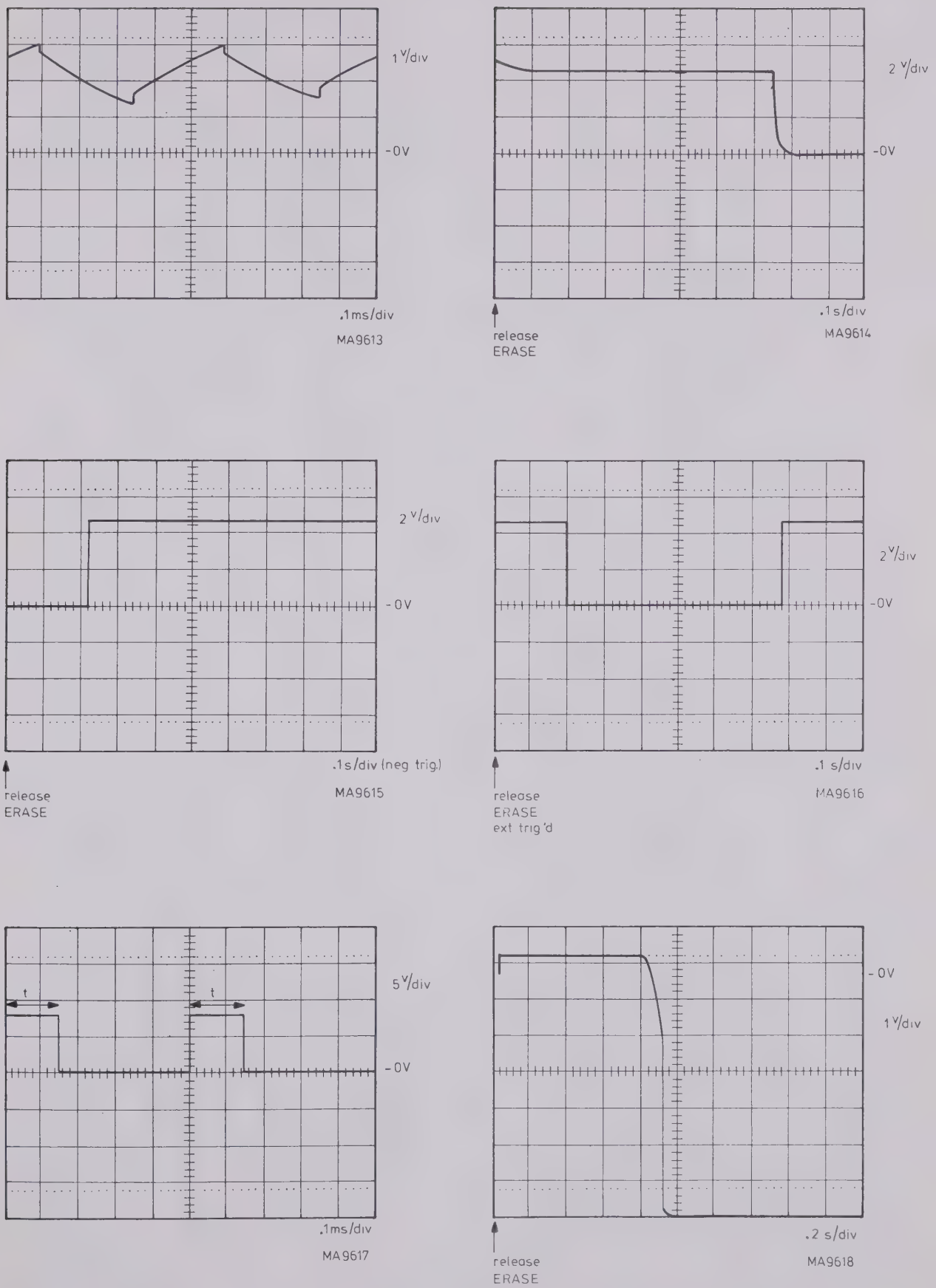


Fig. 3.32. Some wave-forms in the variable persistence/storage circuit

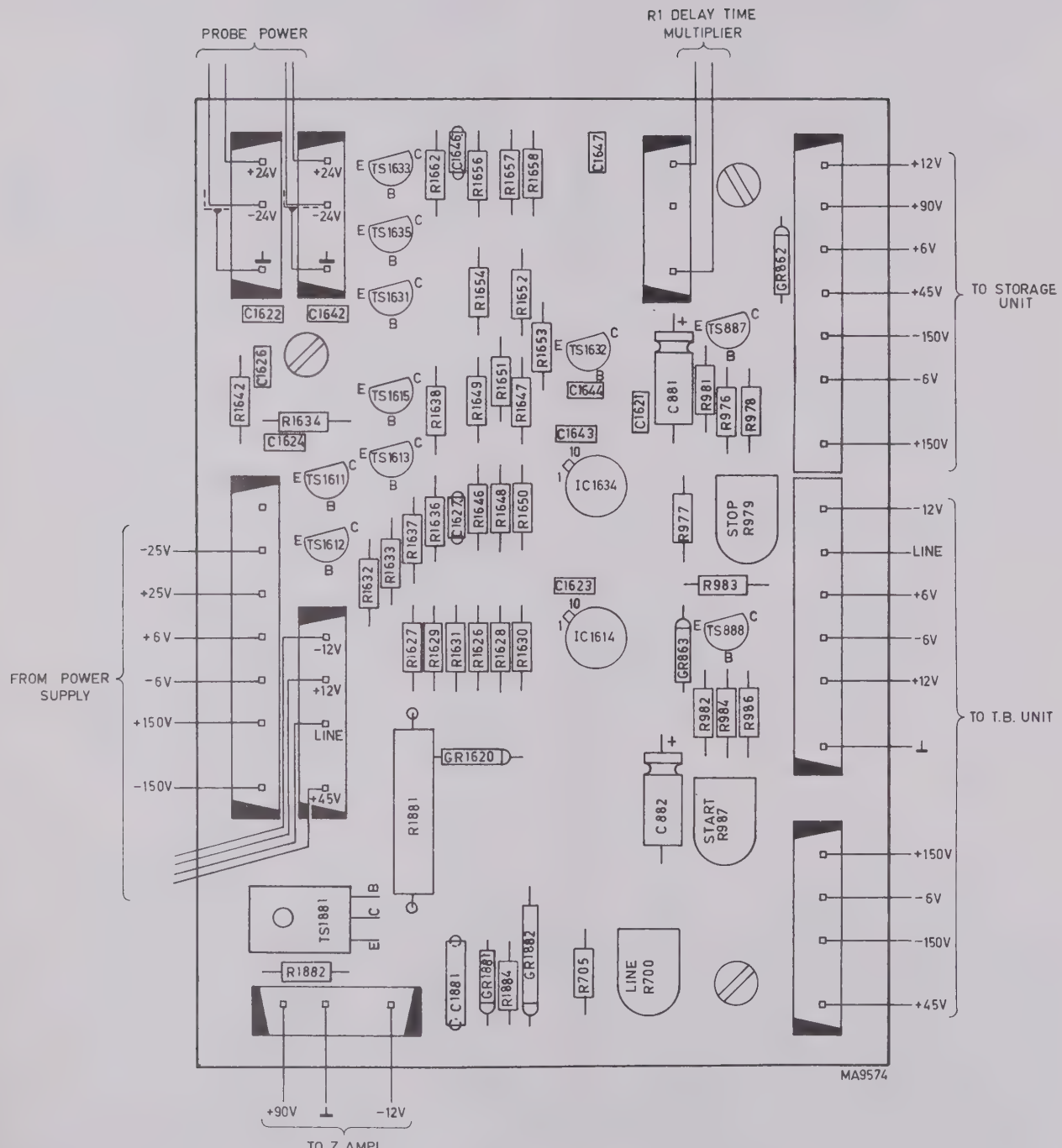


Fig. 3.33. Component lay-out variable persistence/storage

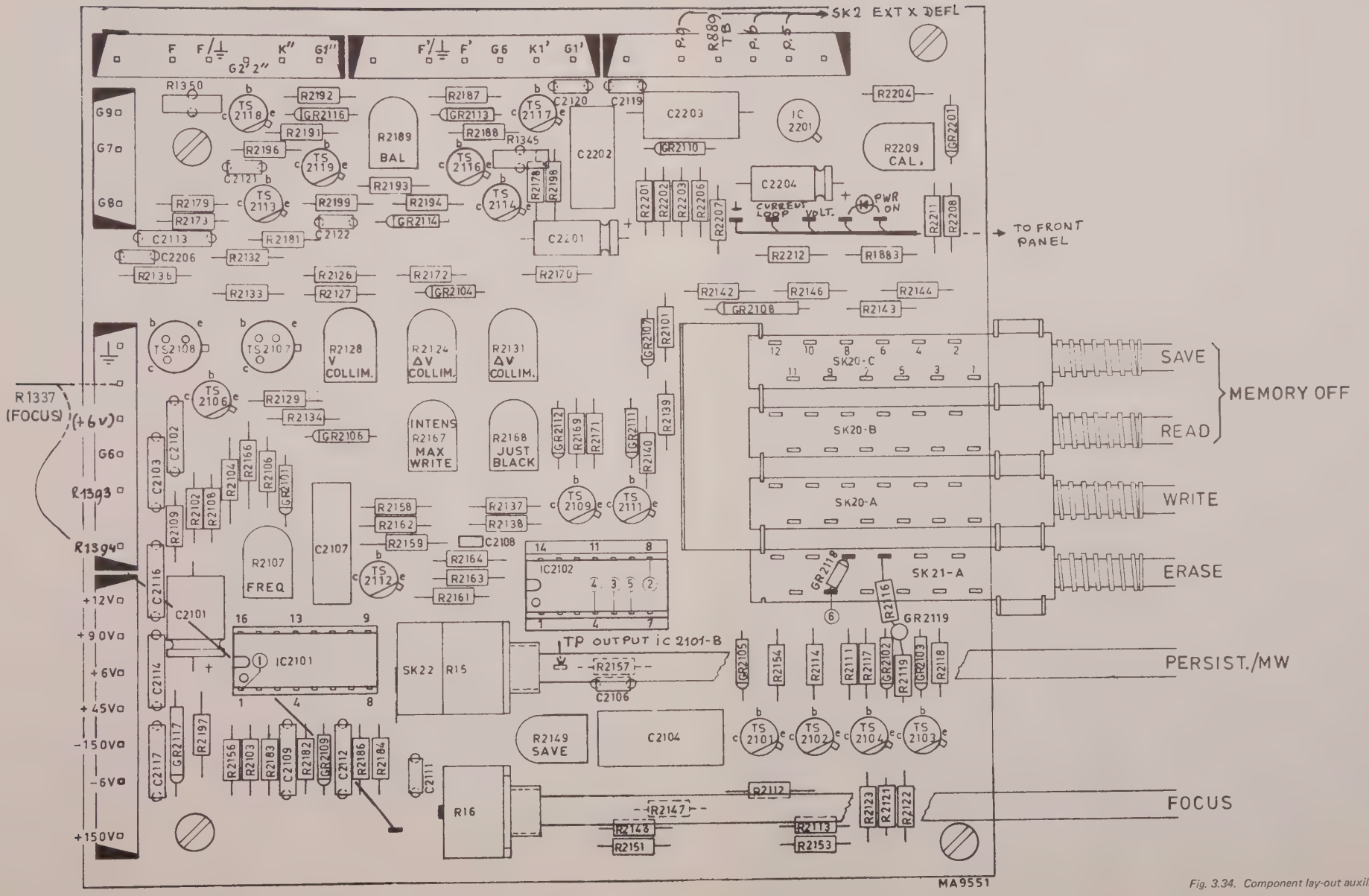


Fig. 3.34. Component lay-out auxilary unit

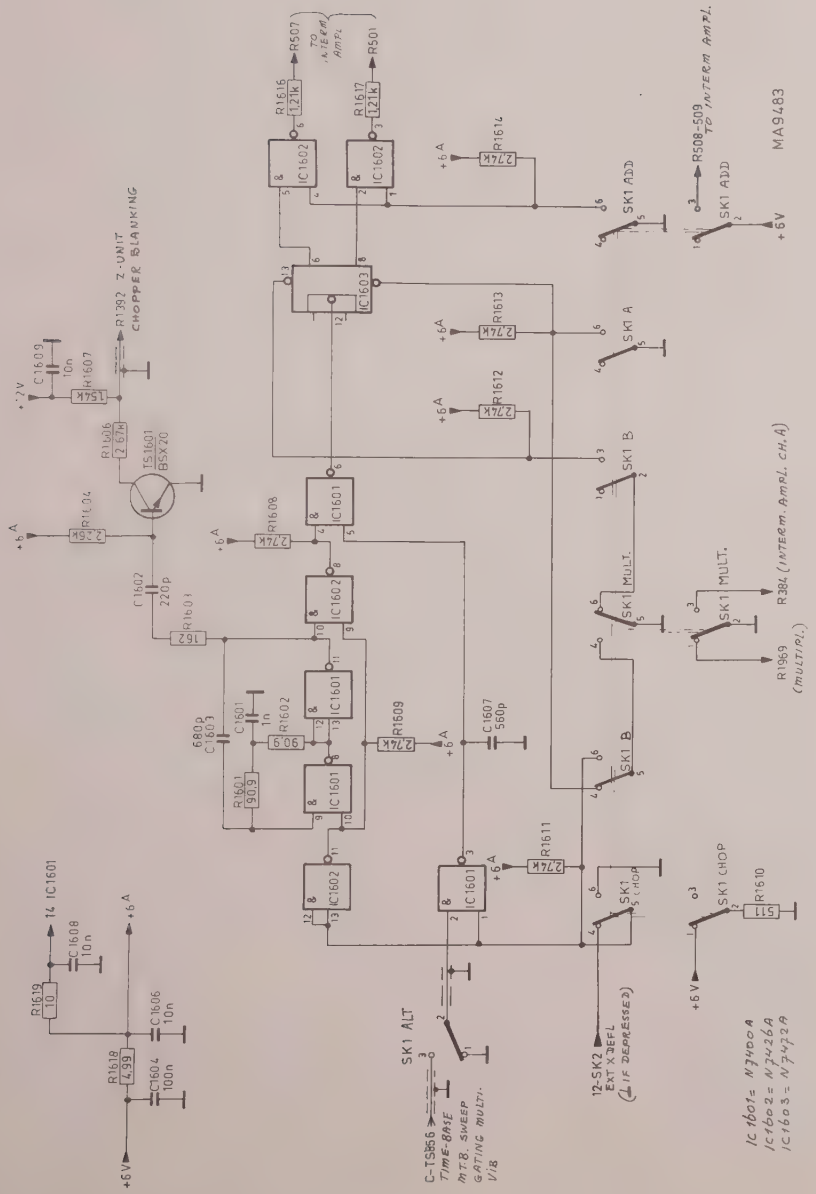


Fig. 3.35. Circuit diagram channel selection logic

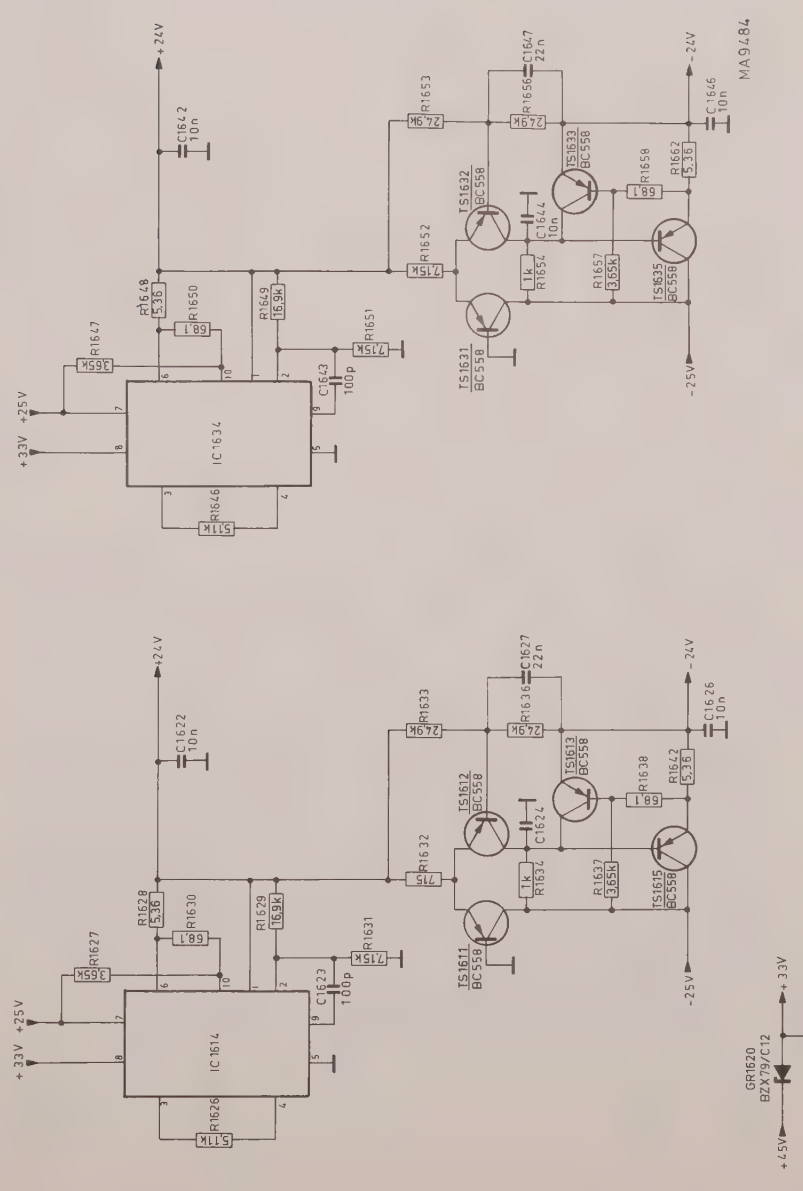


Fig. 3.36. Circuit diagram probe power

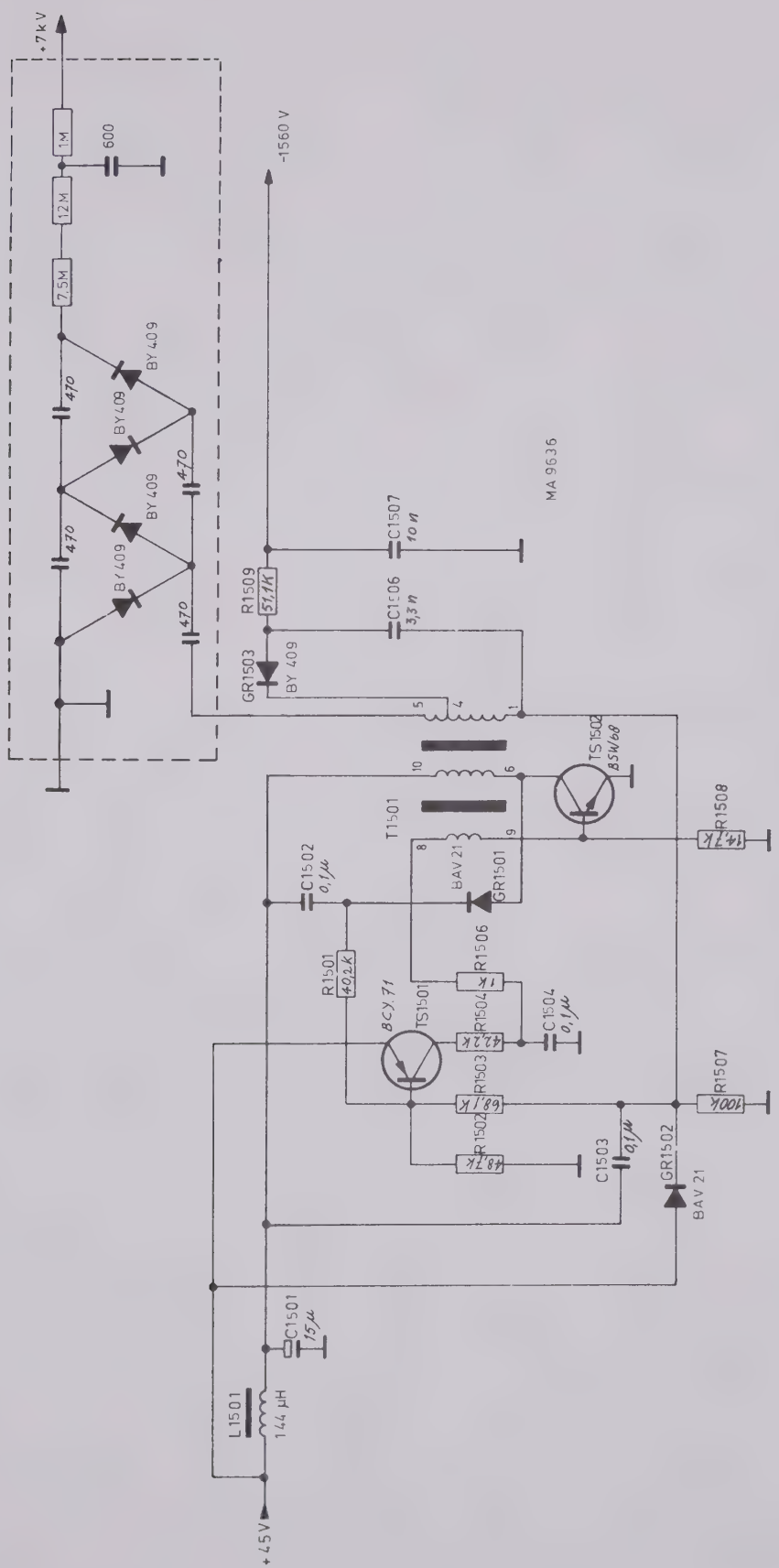


Fig. 3.37. Circuit diagram 2 kV unit with h.t. rectifier

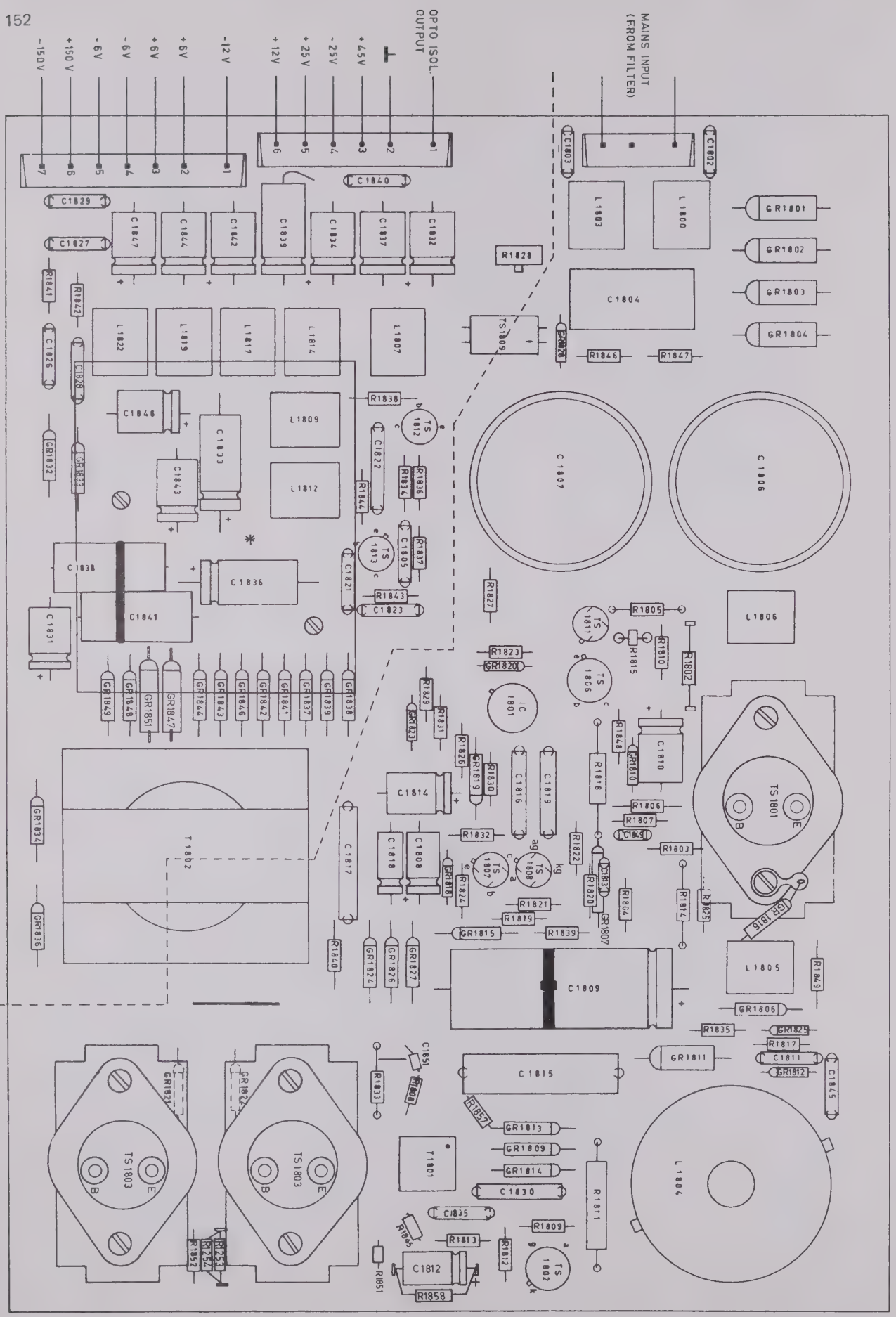


Fig. 3.38. Circuit diagram power supply unit

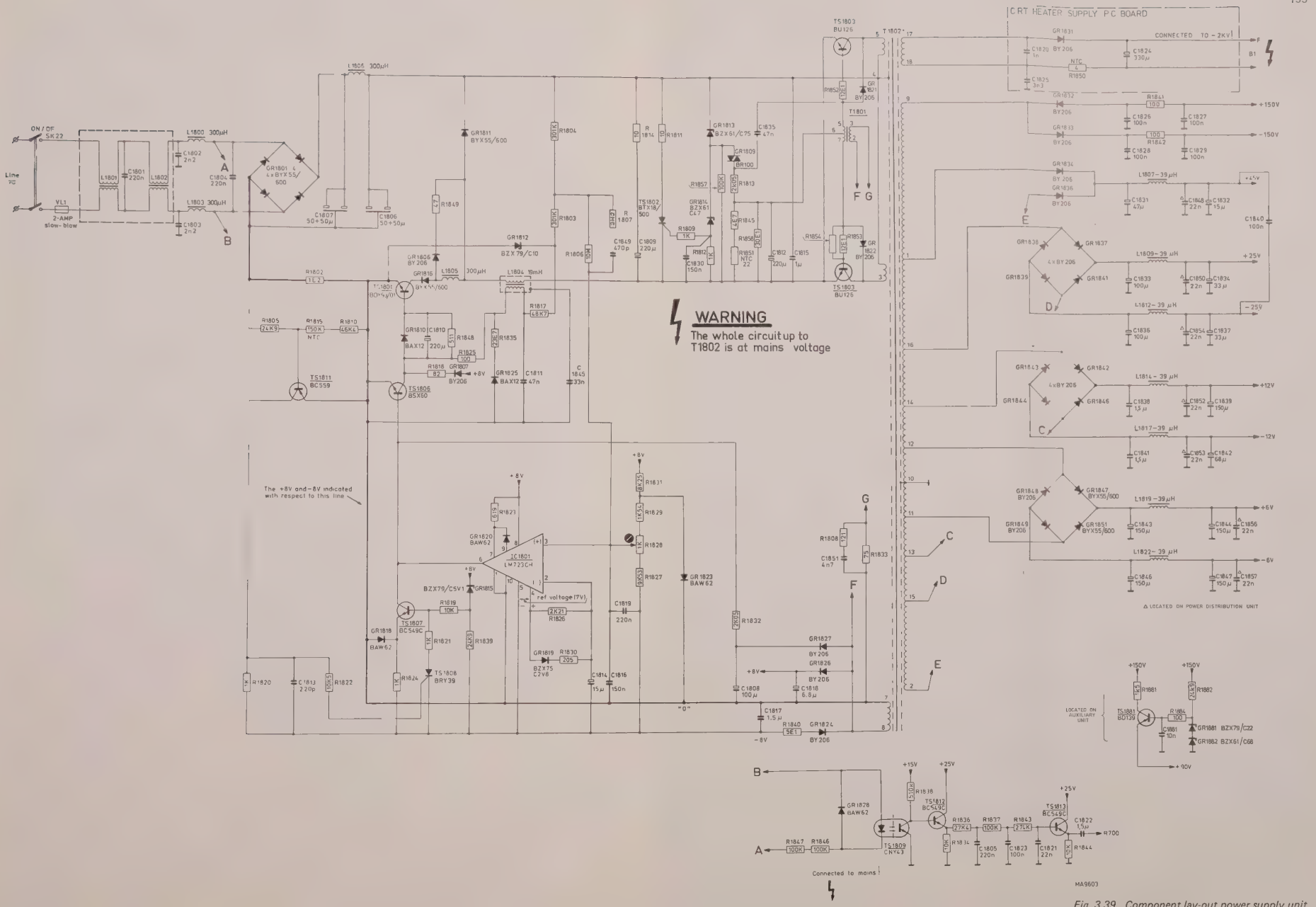

CRT HEATER SUPPLY P.C. BOARD
CONNECTED TO -2KV
WARNING
The whole circuit up to T1802 is at mains voltage
The +8V and -8V indicated with respect to this line
ref voltage (7V)
"0"
LOCATED ON POWER DISTRIBUTION UNIT
LOCATED ON AUXILIARY UNIT
Connected to mains
MA9603

Fig. 3.39. Component lay-out power supply unit

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS

(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① Country	② Day Month Year	③ Typenumber /Version	④ Factory/Serial no.
32	150475	OPM3260/02	DO0783

CODED FAILURE DESCRIPTION ⑥

⑤ Nature of call	Location	Component/sequence no.	Category
☐ Installation		TS0607	5
☐ Pre sale repair		R00631	2
☐ Preventive maintenance	0021	990001	4
☒ Corrective maintenance			
☐ Other			

⑦ *Job completed* ☒

Working time ⑧ ☐☐12 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 32 = Switzerland

②Day Month Year 150475 = 15 April 1975

③Type number/Version OPM32600/02 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number DO0783 = DO 783 These data are mentioned on the type plate of the instrument

⑤ Nature of call: Enter a cross in the relevant box

⑥ Coded failure description

Location

☐☐☐☐

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

☐☐☐☐☐☐

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric,the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000 Unknown/Not applicable
990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002 Knob (incl. dial knob, cap, etc.)
990003 Probe (only if attached to instrument)
990004 Leads and associated plugs
990005 Holder (valve,transistor, fuse, board, etc.)
990006 Complete unit (p.w. board, h.t. unit, etc.)
990007 Accessory (only those without type number)
990008 Documentation (manual, supplement, etc.)
990009 Foreign object
990099 Miscellaneous

Category

☐

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement (of transistor, resistor, etc.)
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

⑦ Job completed: Enter a cross when the job has been completed.

⑧ Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

☐☐12 = 1,2 working hours (1 h 12 min.)

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